

THE COMPLEXITY OF COGNITIVE STRUCTURE IN RELATION  
TO SCHOLASTIC ACHIEVEMENT

by

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## PREFACE

"Intellectual abilities and cognitive controls are not isolated aspects of cognitive organisation, but are mutuallr interrelated. The arbitrary distinction that has sometimes been maintained between intelligence and broad scale organisation of cognition thus seem inappropriate."

Gardner, Jackson and Messick  
(1960 p123)

"An environment must be suited to the species; if it isn't, the organism dies or goes elsewhere."

Sanford (1962 p727)

"While it may be true that pearls come from aggravated oysters, you can only get milk from contented cows. Pearls and milk each have their uses and people will exercise their preference for one or the other, but it would be a pointless exercise in freedom to insist on milking oysters."

Stern (1962 p9)

"Few would dispute that a major goal of education is to instil in students a differentiated view of the world in which they live. Whether our concern is foreign or domestic politics, religion, literature, art or science, we should consider the educational entrprise a success to the extent that students bring a multidimensional outlook to bear upon particular domains. Primitive categorisations .... will generally fail to do justice to the complexity present in most environmental events."

Nathan Kogan (1971 p274-5)

## I ABSTRACT

This study is concerned with patterns of information search and utilisation, and the effect these have on the areas of academic interest and the level of achievement within these areas as a result a fit between the individual and his environment. In particular, the study deals with the scholar's level of cognitive complexity as described by Harvey, Hunt and Schroder (1961) and the effect such complexity level has upon subject preference in the final school year and whether this in turn effects the level of competence and achievement of the pupil.

It will be argued that individual differences in cognitive style or information processing strategies act as moderator variables, resulting in a preference for and relative success in some rather than other domains of intellectual activity. A distinction is drawn between styles that encourage the consideration of a fairly wide range of variables, and those that favour a more restricted range in any given situation. Furthermore, it is argued that the natural sciences, in nature and educational aims, favour individuals with restricted styles, while the arts and humanities favour the "broader" cognitive styles.

A link is drawn between these styles and the complexity of the individual's cognitive structure, and the hypothesis is tested that a preference for and success in the arts as against the sciences is a function of an increase in complexity. Results in support of the hypothesis is presented and implications of the findings are discussed.

PREAMBLE/....



## II PREAMBLE

A convenient take-off point in an account of the historical development of which this study can be seen to be a continuation is the epistemology of Kant. Kant, in accounting for Man's knowledge of his universe, found it necessary to distinguish between two aspects of this knowledge - phenomena and noumena. By phenomena Kant meant the everyday world of "sense-data" - that which is perceived and/or experienced; by noumena he meant an ultimate reality beyond experience, a metaphysical realm upon which the experience of of the phenomena depended. In other words, Kant's philosophy postulates an absolute reality beyond our experience and upon which our experience (and hence our knowledge) depends.

However, this proposition is ad hoc in nature and undemonstrable. Even Kant had to concede this, stating that in fact nothing could be said of the noumena except the necessity of their existence, for all knowledge of this metaphysical realm is achieved only through experience. Furthermore, according to Kant, this knowledge is governed by certain interpretative "categories of mind" which act as parameters or limits of experience - these "categories" include time, space, causality, etc. (Today these would probably be termed universals of cognition or experience.)

What is important here is Kant's observation that knowledge of the world is essentially subjective, phenomenal, though of course certain central aspects of experience are shared and by  
common/....

common usage come to be more or less well defined. However, we can never know the objective, metaphysical world of noumena. This leads to the observation generally overlooked by psychology in the past, especially the positivistic learning theory of early behaviourism, namely that the world is always and only a world as interpreted by the individual, i.e. we do not merely perceive the world but we actively order it. An examination of the perceptual constancies, especially those of vision - shape, colour, size, form - points to the important role played by central cognitive processes even at a perceptual level. As long ago as 1905, Potebnya noted that "Between the thing and cognition there always comes the sum of acquired abilities and tradition." (Quoted by Morton 1971 p646.) The role of cultural and linguistic differences in the cognitive processes, linguistic relativism etc. are all vital to this view of perception and cognition as interpretation.

In order to understand the development, and hence the nature, of the interpretative structure the individual employs in his transaction with the world, Piaget (eg 1932) looks at the intellectual growth of the child and concludes that it is built up in a number of steps from the child's experiences by processes of differentiation and integration - or as he terms it, as a result of assimilation and accommodation. Piaget argues that the child progresses from birth to maturity through a series of stages, each more complex than, and building on, the previous stage. Essentially we have a circular process whereby the child assimilates or interprets the world in terms of a certain ongoing  
frame/....

frame of reference or schema, until the schemata used prove to be no longer adequate in their primitive categorisation of what is perceived and disequilibrium occurs. At this stage a major reorientation of the child's basic assumptions (accommodation) results, and a new psychological framework or set of schemata is laid down, incorporating all that has gone before and restoring equilibrium. This continuous circular process of accommodation and assimilation finally results in a fairly well organised and stable set of relations in terms of which the individual categorises his universe.

The learning history of an individual is generally so rich and varied that under slightly different circumstances two identical sensory inputs will be interpreted in widely differing ways - depending on how the stimulus is perceived - i.e. on which schema is used. An example of this kind of multiple interpretation or the use of different schemata is provided by a study in which Humphrey (1933) successfully conditioned an arm withdrawal response to a specific musical note (say "G") using a shock as the UCS and yet failed to elicit any withdrawal when a piece of music was presented - despite the fact that the excerpt contained the note "G" fourteen or fifteen times. This suggests that the cue value of the note "G" in the "conditioning" schema was entirely lacking when the interpretative schema was that of "music".

Thus, in accordance with Kantian epistemology, the cognitivist conclusion is reached that Man's transactions in the world, and with the world, is an active process of interpretation and

construction/...

construction in terms of a psychological frame of reference laid down during the development of the child and continually expanding and changing, becoming fairly stable with maturity but continuing until intellectual growth ceases. Furthermore, individuals and classes of individuals will differ in their cognitive structure as a result of both biogenetic and experiential factors while sharing to a certain extent those elements common to his society.

### III COGNITIVE STYLE

As we have seen, individuals differ as a result of differences in biological endowment, and environmental and socialisational factors. The effects and interactions of these differences are well known with respect to such phenomena as intelligence and do not need elaboration here. Suffice it here to say that intellectual performance is related to genetic structure as well as to environmental factors of stimulation, linguistic skill and motivation.

Recent theory, however, has tended to move from a consideration of the products of intellectual activity to the processes involved. Bruner (1963) has, for example, argued that any individual in an interaction with the universe is confronted with masses of data, too much in fact for him to handle. If he tries to take in everything he suffers from "cognitive strain". In order to avoid this, the individual is forced to categorise the data in certain ways, adopting strategies of attention deployment and limiting the amount of information processed. Thus to Bruner and his colleagues (Bruner, Goodnow and Austin 1956) thinking is essentially categorising behaviour. As a result of differences in cognitive capacity and different levels of "strain" tolerance, individuals adopt fairly stable categorising strategies and display characteristic patterns of information selection, processing and utilisation. These patterns of cognitive interaction are relatively stable within the individual, across all cognitive modalities and over time. They have come to be known as cognitive styles.

Cognitive styles are thus defined as individual variation in  
modes/....

modes of perceiving, remembering, and thinking, or as distinctive ways of apprehending, storing, transforming and utilising information. (Kogan 1971 p.244)

Cognitive styles are distinguished from cognitive abilities in that ability is concerned with level of skill whereas style gives greater emphasis to the manner and form of the activity. At the same time it can be argued that stylistic variables will influence level of performance, acting as a moderator variable or control mechanism, determining the nature and the sequence of the stages involved in the performance of the task. Different tasks will require for optimum performance different strategies and sequences and thus level of performance will depend on the specific set and sequence of strategies brought to bear on the task. Frederiksen (1969), in relating specific cognitive abilities to components of verbal learning, has, for example, shown that the individual's level of ability was related to the task characteristics and to the cognitive strategies adopted by the individual. Specific abilities were found to be related to different components of learning under the three conditions used by Frederiksen, their operation being mediated by cognitive strategies.

Messick (1972) believes that the cognitive style or set of strategies adopted by the individual is rooted in early non-intellective factors in the child's development.

"Personality traits may be especially important in mediating the development of cognitive skills, since certain personality/...

personality consistencies may tend to develop earlier than cognitive ones, primarily because the child's initial transactions with the environment implicate affective and behavioural responses during a time when his cognitive response capabilities are gradually evolving."

(1972 p362)

Thus, according to Messick

"Cognitive styles have been conceptualised as information processing habits that develop in congenial ways around underlying personality traits. They function to control and regulate the course of information processing."

(1972 p364)

As a result of this shift in emphasis from the product to the process involved in intellectual activity, recent research has centred around the question of cognitive styles. Messick (1970) has listed and described a number of the more important dimensions that have been identified and explored, both theoretically and empirically, over the last twenty years. These include:-

- 1) Field independence vs. field dependence: an analytical, in contrast to a global, way of perceiving (which) entails a tendency to experience items as discrete from their backgrounds and reflects ability to overcome the influence of an embedding context.
- 2) Scanning: a dimension of individual differences in the extensiveness and intensity of attention deployment, leading to individual variations in the vividness of experience and the span of awareness.

3)/.....

- 3) Breadth of categorisation: Consistent preference for broad inclusiveness, as opposed to narrow exclusiveness, in establishing the acceptable range for specified categories.
- 4) Conceptualising styles: individual differences in the tendency to categorise perceived similarities and differences among stimuli in terms of many differentiated concepts which is a dimension called conceptual differentiation, as well as consistencies in the utilisation of particular conceptualising approaches as bases for forming concepts (such as the routine use in concept formation of thematic or functional relations among stimuli as opposed to the analysis of descriptive attributes or the inference of class membership).
- 5) Reflectiveness vs impulsivity: individual consistencies in the speed with which hypotheses are selected and information processed, with impulsive subjects tending to offer the first answer that occurs to them, even though it is frequently incorrect, and reflective subjects tending to ponder various possibilities before deciding.
- 6) Levelling vs sharpening: reliable variations in assimilation in memory. Subjects at the levelling extreme tend to blur similar memories and to merge perceived objects or events with similar but not identical events recalled from previous experience. Sharpeners, at the other extreme, are less prone to confuse similar objects and, by contrast, may even judge the present to be less similar to the past than is actually the case.

7)/....



7) Constricted vs. flexible control: individual differences in susceptibility to distraction and cognitive interference.

8) Tolerance for incongruous or unrealistic experiences: a dimension of differential willingness to accept perceptions at variance with conventional experience.

Other styles not mentioned by Messick (1970) that have been investigated include:

9) Divergence/convergence - ideational fluency in response to open-ended tests vs ability in tests having only one potential solution.

10) Risk-taking - a style with motivational overtones discriminating between cautious and risk-taking individuals.

Although these styles vary considerably in theoretical heritage and with respect to cognitive mode in which they express themselves, they all seem to have one property in common - individuals tend either to take the world in large chunks and to look at it in broad perspective, or to focus on a few highly relevant data and to concentrate on these. It would seem that this latter strategy has the advantage that one can select a few highly related and task relevant pieces of information and focus attention on them without risk of distraction. This makes for ease of coding or categorisation in terms of the pre-existing cognitive framework (Bruner) and necessitates little accommodation (Piaget). However this state of affairs is achieved at the expense of losing the capacity to make rapid changes in one's cognitive structure.

On/...

On the other hand, taking in as much information as possible involves the risk of cognitive strain, necessitates frequent modification of existing categories and makes intellectual functioning a more arduous task. This strategy leads to good pay-offs in that it involves the advantages of being able to change one's existing mental structures very readily, and of being able to relate widely different-seeming data.

Thus we can make a gross distinction between those cognitive styles which operate globally, seeking and using a wide range of information, and those that are more restrictive in their delimitation of the area of attention deployment. If we argue that any one individual has a finite "cognitive capacity" or ability (though obviously individuals will differ in this capacity), we can argue further that as the area of attention deployment increases, so the discrimination within the area is reduced. Conversely, for an individual of given intellectual "capacity", an increase in discrimination will result in a decrease in the range of information being processed at any one time. An increase in both parameters will lead to cognitive strain, while a decrease in both will lead to sub-optimal performance.

Hudson (1967, 1970) argues that the structure of traditional intelligence measures is geared primarily at tapping the logical precision dimensions, thereby favouring those individuals with a more restricting cognitive style. On the other hand, the recent "creativity" tests have tended to tap the quantitative "range" while/....

while ignoring the qualitative details of test responses (See e.g. Mednick's Remote Associations Test R.A.T.) and Guilford's tests of divergent thinking, etc., which merely count the number of responses to open-ended questions without judging the quality of the responses - except in terms of their probability of occurrence. No attempt is made to assess the appropriateness of responses.

Of the numerous styles that have been described, one that has received a good deal of attention in recent literature is the convergence / divergence dimension first isolated by J.P. Guilford. It is to this style that we must now turn our attention.

#### IV CONVERGENCE AND DIVERGENCE

Guilford (1950) in trying to isolate those cognitive characteristics involved in creativity drew a distinction between the convergent and the divergent production of ideas. This distinction was validated by factor-analytic techniques and these two factors were later (1967) incorporated into his major work "The Structure of the Intellect".

In short the convergent production of ideas is concerned with those situations in which all the information points to a single correct solution eg. 'hot' is to 'cold' as 'wet' is to '...'? The divergent production of ideas on the other hand arises in those situations where the individual is required to give as many solutions to a problem as possible. This latter property, which is characterised by ideational fluency and flexibility, is best measured by open-ended instruments eg. 'What are the uses of (say) a brick?' or 'What have A & B got in common?' etc. Thus a distinction is drawn between the generation of logical possibilities (i.e. divergence) and of logical necessities (i.e. convergence).

Since Guilford's (1950) pioneering work, it has generally been accepted that the creative individual is essentially divergent. It is argued that divergence results in the fluid and prolific generation of solutions to a problem and that this will be a prerequisite for a novel and meaningful solution by freeing the individual from the sterile exploration of dead-end alternatives. Thus creativity came to be linked directly with the divergent production/....

production of a large number of potential solutions to a problem. By the mid-sixties, this basic paradigm had become fully entrenched and the terms "divergent" and "creative" had come to be used almost synonymously, especially by American researchers. Open-ended tests were (and still are to a large extent - See e.g. Miller et. al. 1970 and Nicholls 1972) labelled as "creativity tests".

Within the educational system this stress on divergence and ideational freedom has come to form the basis of much current teaching practice. Thus for instance Sears and Hilgard (1964) maintain that:-

"Teachers who are insistent on quiet orderly behaviour, who teach by informative statements, produce task orientated behaviour favourable to convergent thinking; teachers who show personal interest and who avoid critical individual evaluations tend to favour the more creative products of divergent thinking".

(Sears & Hilgard p208-9, my emphasis)

However, with the growing awareness that divergence by itself is a very poor indicator of creative ability (worse, in fact, than the IQ is as a predictor of academic success), a trend away from equating divergence with creativity has become apparent. Perhaps the most radical rejection of this theoretical position has come from the British psychologist Lian Hudson who states that "the diverger has too readily been adopted as the paradigm of Creative Man" (1967 p159) and further that "Open-ended tests are known throughout the United States as "creativity" tests. Yet, as far as I can discover, there is scarcely a shred of.

factual/....

factual support for this." (1967 p126 my emphasis)

The work on which Hudson's two books (1967, 1970) is based is an exploration of those intellectual and personality characteristics that discriminate between individuals choosing an arts or science direction in English senior schools. Working with both traditional intelligence measures (in this case A.H.5 - see Heim 1956) and open-ended tests, Hudson concludes that as far as creativity is concerned

"Original work will come from convergers and divergers alike; and divergence of an individual will determine not whether he is original, but if he is original, the field and style in which his originality will manifest itself. The roots of his originality lie not in his convergence or divergence, but in other aspects of his personality." (1967 p159)

However, more relevant to this thesis is Hudson's main conclusion that "the converger is attracted to the sciences and the diverger is attracted to the arts" (1970 p13) and further that

"Arts specialists are on the whole divergers, physical scientists convergers. Between three and four divergers go into arts subjects like History, English Literature and modern languages for every one that goes into physical science. And vice versa; between three and four convergers do Mathematics, Physics and Chemistry for every one that goes into arts." (1967 p56-7)

Hudson also believes that traditional intelligence measures favour convergent thinking patterns rather than divergent ones with the result that scientists, i.e. convergers will have higher IQ scores than their divergent arts companions. By the same

token/....

token these scientists can be expected to be inferior on the "Creativity" or divergent thinking tests.

"Most art specialists, weak at IQ tests, were much better at the open-ended ones; most scientists were the reverse."

(1967 p56)

In a closer analysis of the personality and intellectual fabric of the converger and diverger, Hudson notes fairly well defined syndromes characteristic of each type of individual. Convergents as we have seen tend to do better at IQ tests. In addition, they are characterised by a general conservatism and conformity to group and peer values and are more likely to accept authority-related cues as sufficient reason for his actions. He disapproves of any deviation from the group norms and displays a general need for order and certainty. Divergers, on the other hand, score lower on I.Q. tests, but tend to be more tolerant and more open in their belief systems. They tend to have a wider range of interests and to be able to hold simultaneously apparently conflicting points of view, implying a wider frame of reference and an ability to tolerate ambiguity and uncertainty.

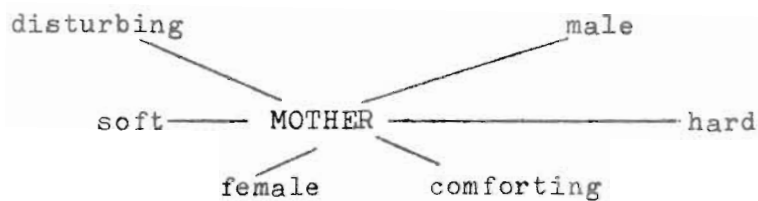
## V COGNITIVE COMPLEXITY

One particularly useful approach to the question of differences in the cognitive structure by means of which the individual organises his world stems from the construct theory of Kelly (1955). Kelly believed that Man is essentially a scientist and that he forms theories about the world from his experiences and that he then tests the implications of these theories against ensuing events, i.e. he is hypotheticodeductive and as Kelly phrases it "anticipates events by construing their replications" - by postulating their outcomes. This is the construction corollary derived from his fundamental postulate, which states that "a person's processes are psychologically channellised by the ways in which he anticipates events". By this Kelly means that the individual acts according to his interpretation of the stimulus, i.e. in terms of the schemata brought to bear on the situation. (See the description of Humphrey's (1933) conditioning study above.) Finally, Kelly believes that "persons differ from each other in their construction of events". (The individuality corollary.) (For a fuller explication of Kelly's theoretical position, see Bannister and Mair 1968.)

According to Kelly, Man interprets or construes his world in terms of a finite number of dichotomous or bipolar constructs (dichotomy corollary) against which the object of perception is judged. For example the concept MOTHER may possibly be judged in terms of the constructs SOFT-HARD, COMFORTING-DISTURBING, MALE-FEMALE, etc. Kelly, believing that the constructs used are  
often/....



often prelinguistic, uses triads of ego-involving people - parents, teacher, girl-friend etc. - to establish a construct that two people in the triad have but the third lacks. All individuals are then judged against this construct. Using a matrix of such constructs known as the Role Repertory Grid (Rep. Test), any given (social) object is made meaningful by being located in a multi-dimensional grid that constitutes the individual's psychological space. Thus using the example of MOTHER above:



Therefore the psychological meaning of any object for the individual is seen to lie at the point of intersection of its constituent constructs. (Compare this with Sussure's concept of Semantics where the meaning of a word is located at the point of intersection of an infinite number of dimensions within a multi-dimensional semantic space. "A given term is like the centre of a constellation, the point at which an infinite number of co-ordinated points converge." (Quoted from Ullman 1962 p238.)

Developing from this theory and especially from Kelly's individuality corollary that "persons differ from each other in their construction of events", it is argued that these differences result from the nature of the constructs used, and from the way

in/....

in which they are used. We have seen above that although individuals will differ in the constructs they habitually use in the analysis of any situation, the range of constructs available to him is not in fact unlimited, being circumscribed by cultural and bio-physical factors. However, individuals do differ in the number of constructs they generally employ and the degree to which they are interrelated. Differences in the number of constructs normally used in interpreting the universe will have important consequences. The use of only a few dimensions will result in a relatively simplistic, compartmentalised view of the world in so far as the individual will be able to make few, if any, alternative constructions of the situation. On the other hand, the cognitively complex person who has a large number of constructs in an intricately interrelated structure will have this ability, in that the wide range of dimensions ensures that categorisation or compartmentalisation is not absolute. As a result, he can be expected to have a more involved, complex view of the world, to be more relative in his judgements and to be able to tolerate a greater degree of ambiguity and uncertainty than the cognitively simple.

This prediction has been supported by a number of theorists.

Driver and Streufert (1965, 1966a, 1966b) and Schroder et al. (1967), have shown e.g. that individual or group differences in the complexity of conceptual structure account for some of the differences in attitude change (Streufert, 1965), perception of others' intentions and strategies (Streufert & Driver, 1965), decision-making characteristics (Streufert & Schroder, 1965), information orientation/....

orientation, information search, and information utilization (Karlins & Lamm, 1967; Stager, 1967; Streufert, Suedfeld, & Driver, 1965; Suedfeld & Streufert, 1966), and other areas concerned with social interaction (Crano & Schroder, 1967; Sieber & Lanzetta, 1964; Tuckman, 1964).

Bieri (1968) too has shown that in impression-formation situations, where individuals are presented sequentially with two accounts of some person or object containing contradictory information about the person or object, subjects rated as cognitively simple show far greater recency effects than complex subjects who tend to react to the conflicting information in a less extreme manner. As a result their final impressions are more balanced and better integrated than those of the cognitively simple.

Numerous researchers (e.g. Bieri 1955 1961, Leventhal 1957, Tripodi & Bieri 1964) have all shown that complex individuals are better able to make discriminations among incongruent stimuli than less complex individuals. Larsen (1971) suggests that this can be interpreted to mean that "cognitively complex subjects can differentiate, anticipate and react more appropriately to their environment." (p120) Similarly, Streufert and Schroder (1964) have shown that structurally simple persons respond more directly to immediate environmental information and tend to respond in a less integrated, less strategic fashion than more complex people. MacNeil and Rule (1970) present evidence showing a preference for complex information by complex individuals in a sensory deprivation situation while simple, repetitive information was preferred by conceptually simple subjects.

Generally/....

Generally the experimental evidence points to the fact that the individuals judged to be structurally simple are less able or willing to handle complex information than complex individuals and that this occurs at all levels of information selection and utilization. Bieri (1968) proposes that this results from the fact that the cognitively complex subject has more structure in his cognitive system than a simple subject. Thus the complex person has a larger network of interacting constructs which makes his reference point much broader and more diffuse than that of a simple person. Because of this, the complex individual is capable of integrating diametrically opposed traits of a stimulus object or person into a final ambivalent categorisation, while the simple person shows a large recency effect. This would correspond to the assertion that cognitively simple people are sensitive to a "black-white" organisation, whereas complex people are sensitive to shades of grey.

The simple individual can thus be expected to prefer a fairly circumscribed range of information, for to move beyond these confines will result in cognitive strain and will necessitate a "translation" or simplification of the data into a more polarised black-white relationship. This simplification of the incoming information limits, in its turn, the integrative ability of the individual with a deleterious effect on his ability to perceive new relationships. (For an analysis of creativity in terms of structural complexity, see Karlins 1967.)

## Measurement of Complexity

The measurement of cognitive complexity has taken one of two broad directions. Bieri and his colleagues (Bieri 1966, 1968; Crockett 1965; Scott 1962, 1963) have based their measurement techniques on modifications of Kelly's (1955) Repertory Grid to obtain fairly specific and quantifiable measures of such structural properties as construct differentiation (number of constructs), articulation (number of segments within a given construct) and other aspects of what MacNeil (In press) has termed dimensional integrative complexity.

An alternative approach to the measurement of complexity, and the one used in this study, is based on a general assessment of the individual's ability to integrate and utilise information. This measure looks not to the number of constructs used (differentiation), but to the conceptual and combinatorial rules used by the person in the organisation and utilisation of the information. (This measure of what MacNeil, in press, has termed rule integrative complexity is thus an indirect measure of cognitive complexity and is, as a result, less specific. Analysis of rule integrative complexity involves a semi-projective technique in which the individual is asked to express his views on a number of ego-involving situations and judgement then made on the complexity of the thought processes used by the individual. Schroder (e.g. Schroder, Driver and Streufert 1967) has used a Paragraph Completion Test in which the individual is required to complete a paragraph beginning with something like "Rules...." or "When I am criticised....". Harvey  
1966/....

(1966) uses a standardised format with the stem "This I believe about...." in conjunction with a number of referents such as "The American way of life", "Friends", "Guilt", etc. This study used Harvey's "This-I-Believe" Test (TIBT), though the items used were not always the same as his.

Now, according to Harvey and his co-workers (Harvey 1966; Harvey, Hunt and Schroder 1961; Greaves 1971a, 1971b) the complexity of the individual's cognitive structure results in him adopting characteristic ways of behaving and as a result, people can be ascribed to one of four "systems" or levels of conceptual development ranging from concrete, absolute modes of thinking to abstract, relative modes. Basic to this Conceptual Systems Theory is the belief that each level of conceptual development or "system" has an unique constellation of response dispositions associated with it, such that one can meaningfully distinguish between persons on the basis of their cognitive types. Person tend to act and think similarly to every other person at a given level of complexity, yet very differently from persons at another level. (See Greaves 1971a p52). Scoring of the TIBT strives to place the individual at a given level that will best account for his observed behaviour.

Briefly the characteristics of these four levels are:-

SYSTEM 1 - most concrete.

High absolutism and closedness of thought and belief systems;  
high evaluativeness; high positive dependence on institutional  
authority; high identification with social roles and status

positions/....

positions; high conventionality.

SYSTEM 2 - second most concrete.

These individuals are characterised by a rejection of authority-related cues, but at the same time are devoid of any other reliable and stable guidelines. Though they display negative valence towards the same referents that are of high positive relevance to system 1 individuals, it is important to note that both use the same external sources as points of reference.

SYSTEM 3 - more abstract.

The system 3 individual has a relatively well integrated conceptual structure but is dependent to a large extent on group norms and, with the exception of the conformity of the system 1 person to authority, shows the most acquiescence to the generalised "other", resulting in unthinking social accommodation and the need for a large number of friends, etc.

SYSTEM 4 - most abstract.

Because of their highly differentiated and integrated conceptual system, these individuals hold balanced and well considered views and are more reliant upon their own authority and more accepting of their own standards. They are neither indiscriminate yielders to, nor invariant rebels against, institutionalised authority. They display a low need for structure, relatively high tolerance of ambiguity, a high ability to change "set" and a tendency to avoid stereotypes and banality, showing a preference for complex stimuli.

In order/....

In order to measure these response tendencies, Harvey includes in his test such ego-involving referents as marriage, the American way of life, religion, people, friendship, etc. The individual is given two minutes in which to write at least two sentences expressing his belief about these areas. Assessment of complexity from the response protocols has a fairly high test-retest reliability - in the high 80's based on several different studies and stretching over 6 months. (Greaves 1971b) Inter-tester reliability is also good, Greaves (ibid) reporting values of .90+, though pointing out that the semi-projective nature of the test requires fairly intensive training and a thorough understanding of the theoretical underpinnings of the instrument. (p55-56) Results reported by Schroder et al (1967) show that the P.C.T. (Paragraph Completion Test ) - and hence by implication the T.I.B.T. as well - are not contaminated by verbal fluency (as judged by length of sentence), nor by social desirability. In this study correlations of .23 and .12 were obtained between complexity and verbal and non-verbal I.Q. respectively. Finally, Greaves 1971b reporting on item strength, shows a correlation of between .18 and .43 with overall scores, depending on item tested.



## VI COMPLEXITY AND COGNITIVE STYLE

It is one of the primary aims of this study to suggest that a potentially useful way of looking at all the different cognitive styles discussed above is that they are manifestations of a single structure (Levi-Strauss e.g. 1963, Piaget 1968). Piaget defines structuralism as that which "seeks to explain empirical systems by postulating 'deep' structures from which the former are in some manner derivable" and speaks also of "transformational interaction." (p98). Levi-Strauss would, for example, maintain that kinship hierarchies, religious practices, linguistic patterns, marriage laws, etc. all reflect in different ways a single tribal structure, even though little direct correlation is found between any two aspects of the structure. Thus, what is being suggested here is that all the cognitive styles described by e.g. Messick (1970) as well as the divergence/convergence styles of Guilford (1950) and Hudson (1967) all derive from a single superset or structure which manifests itself in slightly different ways in different areas of cognition. Furthermore, it is argued here that these various styles all reflect a structure that is best characterised in terms of its relative complexity or simplicity. In other words, structural complexity of simplicity is seen as the central unifying factor that accounts for the numerous cognitive styles.

A number of theorists would disagree with this formulation. Bieri (1961, 1966) regards complexity as relating solely to interpersonal behaviour - "cognitive complexity may be defined as the capacity to construe social behaviour in a multidimensional way."(Bieri 1966 p185)

Messick/....

Messick (1970- and Kogan (1971), following Bieri, would suggest that the simplicity/complexity dimension is merely another cognitive style with implications for social interaction. However, Bieri's earlier work points to the possibility of the model suggested above. For example, he maintains (1961) that:-

"Cognitive complexity is associated with various styles of response.... These cognitive or response modes all suggest cognitive processes characterised by the tendency to make finer discriminations in perception. In this regard we may cite Klein's concepts of levelling and sharpening (1958), Mednick's findings of individual differences in stimulus generalisation tendencies (1955), the work on repressors or sensitizers (Gordon 1957) and the work of Pettigrew (1958) and Wallach and Caron (1959) on categorising." (Bieri 1961 p359)

On the other hand, the model put forward is compatible with Harvey, Hunt and Schroder's (1961) conception of complexity in so far as they argue that the dimension applies to cognition in general. It should be noted that Bieri's measure of complexity is based exclusively on differentiation - the number of constructs or dimensions used - while Harvey et al are concerned with the way in which the constructs are used in the organisation and integration of the incoming information and as such their measures yield an index of integrative complexity. Bieri employs a modification of Kelly's Rep. Test, Harvey a paragraph completion technique.

The ease with which the numerous cognitive styles can be accounted for in terms of a structural complexity/simplicity framework gives support to this thesis. For example, the styles Bieri says are characterised by finer discriminations in perception are all

thus/....

thus attributable to a more complex structure. Witkin's field dependence (Witkin et al 1962) can be interpreted as the inability of the individual to free himself perceptually from his immediate environment for reason of a limited number of constructs, all of which are context bound. A more complex structure would permit some external reference point, thereby reducing the degree of perceptual dependence. (A later formulation of this dimension as a global as against an analytic style is significant because of its cognitive overtones.)\* Similarly, breadth of categorisation and tolerance of ambiguity suggests a complex network of interrelated constructs that serve to provide a large number of "contact points" or construct intersections which, as we have argued above, reduces the degree of dissonance experienced.

Finally, evidence for this position is provided by reports of correlation between the various styles. Wallach and Kogan (1965) report significant positive correlations between category breadth and divergence, while Bierl, Bradburn and Galinsky (1958) have shown a significant relation between preference for complex stimuli (in the form of drawings) and field-independence in males. Ausubel (1968) reports that "Open-minded individuals tend to score higher than closed-minded people on tests of verbal ability, school achievement and ability to form remote verbal associations." (p 173 My emphasis) Stones and Gordon (1972) conclude that "the analytic dimension of Kagan (Kagan et al 1963) and the field-independent notion of Witkin (Witkin et al 1962) originally had many similarities/....

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\*It is interesting to note Piaget's concern with perceptual development as one aspect of his theory of cognitive development - which process can be seen to involve the "complexification" of the cognitive structure through hierarchisation and integration.

similarities, but changes in emphases by the two researchers and modifications of the measuring instrument have resulted in two tests which are tapping different dimensions of cognitive style." (p190). It is further argued that convergence and divergence are also manifestations of the individual's cognitive structure and in particular that divergence is a characteristic of the structurally complex person while convergence reflects a structural simplicity.

The model put forward thus disagrees with those theorists who would limit the concept of cognitive complexity to social behaviour (or any other single area of interaction.) Rather, complexity is seen as the degree of organisation (hierarchisation and integration) of the cognitive structure resulting from the Piagetian processes of assimilation and accommodation which mediates the interpretation of what is perceived and/or experienced. Nor does this necessarily imply that an equal degree of complexity will be manifested in all cognitive domains or across all cognitive tasks. It merely suggests that structural complexity provides the underlying competence to perform in a complex integrated way, and that this applies equally to intellectual and social phenomena. This formulation therefore does not take sides in the domain specificity/generalizability controversy but suggests merely an "umbrella" or unifying concept giving rise by way of transformations to the numerous cognitive styles or control mechanisms.

A brief look at the cognitive and personality variables attributed quite independently to individuals judged as complex or simple and/....

and as divergent or convergent shows the degree to which these concepts are interrelated.

- 1) The diverger is, by definition, able to give a large number of responses to an open-ended question. This would suggest that the stimulus item is located in a matrix with a wide range of interrelated constructs, which by definition is indicative of structural complexity.
- 2) Divergers, according to Hudson (1967) are capable of entertaining conflicting systems of values (p82) and are more tolerant of ambiguity (p83). These are both properties of the complex individual, who by dint of his network of constructs is able to reconcile conflicting information.
- 3) The diverger "is liberal in his attitudes and seems less prone than the converger to accept beliefs on trust or to think in conventional terms." (p109) A major characteristic of the cognitively simple individual is his dependence on authority, both secular and religious, and his unquestioning acceptance of social norms and values. The converger disapproves of deviation from the group.
- 4) Finally, Hudson (1967) notes that as an ego-defence the converger uses a process of "compartmentalisation".

"The chief virtue of this is that the person concerned is able to zone his preoccupations, coping with them one by one, rather than having to handle them simultaneously."

(p24)

thereby minimising cognitive load and the risk of subsequent strain. This very fact of compartmentalisation implies a restricted interaction between the various areas of conflict

and/..

and between cognitive domains.

In summary, then, it is seen from Hudson's findings that convergers are conservative and conform to group values coincides with Harvey's et al findings that conceptually simple people are authority related and have a strong need for order and structure. On the other hand, the cognitively complex individual is more relative in his judgements, less stereotyped in his behaviour and more tolerant in his attitudes. That this is true also of divergers, gives further strength to the argument that convergence is symptomatic of structural simplicity, and that divergence reflects complexity.

In an attempt to understand and expand Hudson's (1967) findings that divergers are drawn to the arts and convergers to the sciences, it is necessary to examine briefly the characteristics peculiar to each group of subjects and which serve to differentiate between them. In other words, we must examine the "task requirements" involved in learning the two types of material, and must find some reason for this apparent preference.

## VII TASK REQUIREMENTS

If we look even briefly at the structure and intellectual demands of the various areas of knowledge, it will be seen that these range on a continuum from "fact" to "opinion", that is, from the empirical and demonstrable to the logical and metaphysical. Hirst (1969) distinguishes between the following domains of knowledge, each characterised by its own internal structure and level of objectivity:- Mathematics, Physical Sciences, Human Sciences and History, and the Fine Arts, Morals, Religion and Philosophy. (p151)

Hajnal (1972), in his turn, distinguishes between what he terms formal and descriptive or non-formal types of subject domain. Of the formal subjects, he notes:

"Because the learner must proceed systematically from the less to the more advanced parts of the subject, one may liken the learning of "formal" knowledge to the climbing of a ladder. One cannot reach the top of the ladder except by climbing over the lower steps. If the gap between the rungs is too great, one cannot climb at all. An attempt to skip too many rungs will end in failure." (p162)

On the other hand, descriptive subjects are characterised by a lack of objectivity which necessitates a personal selection and evaluation of what is to be regarded as relevant to the issue in question, and what is not relevant.

Jevons (1969), in a consideration of general educational aims, distinguishes two processes - the acquisition of depth and the acquisition of breadth. Depth in education is seen as "a function of the intense concentration and focussing of attention that it takes/....

takes to really master some subject area. The area must necessarily be small, but the student can acquire real familiarity with it and come to know his way about it....". Breadth, on the other hand, "means coming to see the subject area in its setting and with its implications, developing an overview rather than tunnel vision". (p114)

If we now look at Ballard's (1971) description of the aims of teaching History, we can see that History is essentially a descriptive subject (in Hajnal's 1972 sense) and is concerned with the acquisition of breadth (in Jevons' 1969 sense.)

"The justification for History teaching does not lie in the acquisition of specified portions of the sum total of fact. In Mathematics or Physics a pupil must master one skill before he can progress to another. Historical judgements are not built up in this way. There is no single event or historical character which rates as a sine qua non in an History syllabus. Some may be more desirable than others, but none is essential. The justification of the study of History at the school level lies in the acquisition of breadth." (p6)

The sciences on the other hand, can be seen to involve what Jevons (1969) terms depth processes. At the same time, the sciences can be seen to involve a progression from the less to the more advanced parts of the subject and as such the sciences are formal in structure. Thus it is argued that the arts subjects are essentially descriptive in nature and depend for their validity on the relative importance attached by the individual to the different contributing variables. On the other hand, the sciences progress in an orderly fashion and, at least at the scholastic level/....



level, are anchored on a bedrock of observable facts and by their own criteria of inter-subjectivity yield verifiable and thus absolute answers to problems in a way that the arts and humanities cannot. Thus it is argued that the sciences are concerned with absolutes while the arts involve selection, interpretation, and evaluation of material in what can only be a subjective process - there are no "correct" solutions. Hajnal (1972) says of the Arts subjects

"The subjects on which an Arts student has to write are fairly general, and often quite abstract. Questions are involved to which no simple answer based on facts is possible; the problems raised are not ones to which there are unique correct solutions." (p141)

A recent analysis of the structure of academic areas at Illinois University (Biglan 1973) shows a major dimension that distinguishes the natural sciences, engineering and agriculture from social sciences, education and the humanities. Biglan notes that this dimension refers to the internal structure of the subjects, and that

"a good short-hand label for the dimension is 'hard-soft'. The dimension appears to provide one kind of empirical support for Kuhn's analysis of the paradigm. By 'paradigm' Kuhn (1962) refers to a body of theory which is subscribed to by all members of the field. The paradigm serves an important organising function ... Fields that have a single paradigm will be characterised by greater consensus about content and method than will fields lacking a paradigm. Kuhn specifically designates physical and biological sciences as paradigmatic while the humanities and education areas are non-paradigmatic." (p201-202 My emphasis.)

In order to understand the fundamental differences between these

two/....

two domains of knowledge, it is necessary to consider Hayek's (1967) work on pattern recognition. In discussing differences between simple and complex phenomena, Hayek notes the following:

"There seems to exist a fairly easy and adequate way to measure the degree of complexity of different kinds of abstract patterns. The minimum number of elements of which an instance of the pattern must consist in order to exhibit all the characteristic attributes of the class of patterns in question appears to provide an unambiguous criterion". p25

In other words, Hayek is maintaining that for a pattern or object to be regarded as "simple", it must be able to be defined or accounted for in terms of relatively few variables - or to switch back to earlier phraseology, it must be seen to exist at the intersection of relatively few constructs.

He goes on to describe two kinds of complex phenomena:- one that is complex in terms of the number of variables or constructs as just shown; and one that is complex as a result of the combination of elements. To give an example, the different kinds and vast number of proteins would suggest that protein is a complex phenomenon, yet in so far as it consists of different combinations of only 22 different amino acids and that it is sequence and number alone that determine the properties of the protein it can be seen to be simple in the sense defined by Hayek. He continues:

"It has occasionally been questioned whether the phenomena of life, of mind, and of society are really more complex than those of the physical world. This seems to be largely due to a confusion between the degree of complexity/....

plexity characteristic of a peculiar kind of phenomenon and the degree of complexity to which, by a combination of elements, any kind of phenomenon can be built up. Of course, in this manner physical phenomena may achieve any degree of complexity. Yet when we consider the question from the angle of the minimum number of distinct variables a formula or model must possess in order to reproduce the characteristic patterns of structures of different fields (or to exhibit the general laws which these structures obey), the increasing complexity as we proceed from the inanimate to the ('more highly organised') animate and social phenomena becomes fairly obvious.

It is, indeed, surprising how simple in these terms, i.e., in terms of the number of distinct variables, appear all the laws of Physics, and particularly of mechanics, when we look through a collection of formulae expressing them. On the other hand, even such relatively simple constituents of biological phenomena as feedback (or cybernetic) systems, in which a certain combination of physical structures produces an overall structure possessing distinct characteristic properties, require for their description something much more elaborate than anything describing the general laws of mechanics. In fact, when we ask ourselves by what criteria we single out certain phenomena as "mechanical" or "physical" we shall probably find that these laws are simple in the sense defined. Non-physical phenomena are more complex because we call physical what can be described by relatively simple formulae". (Hayek 1967 p25-26) (My emphasis.)

Hayek (1967) thus characterises sciences as essentially simple (in terms of the number of variables to be considered) while the arts and humanities are considered complex. One of the major reasons for the sciences being intersubjectively verifiable is that experimentation is possible in which all variables are controlled, each/....

each being varied in its turn. This is not possible in the arts and humanities - there are too many variables: hence the widespread use of statistical interpretation.

If we accept this description of the arts as "complex" and the sciences as "simple", and further, if we regard cognitive complexity as the willingness or ability to consider a large number of variables simultaneously, then it is reasonable to expect that there will be a correlation between the individual's level of cognitive complexity and the area to which he is attracted. We must now, therefore, consider the question of a match or "fit" between the individual and his environment.

## VIII INDIVIDUAL/ENVIRONMENT FIT

Pervin (1968), in discussing the relation between the individual and his environment, concludes that

"For each individual there are environments that more or less match the characteristics of his personality. A 'match' or 'best fit' of the individual to environment is viewed as expressing itself in high performance, satisfaction, and little stress in the system, whereas 'lack of fit' is viewed as resulting in decreased performance, dissatisfaction, and stress in the system."

(p56)

An example of this is provided by Sapolsky (1965) who has demonstrated that therapist-patient compatibility is an important determinant of therapeutic success. Schroder, Driver and Streufert (1967) use an information-processing model to predict the optimal combination of environmental complexity and the integrative complexity of the person, while Munsinger and Kessen (1964) show that an individual will "prefer environmental input which is at or near the limit of his ability to handle cognitive uncertainty" (p21) and that "Human beings prefer an amount of cognitive uncertainty which matches their processing ability." (p2) Tuckman (1968) has shown that factors correlating with maximum job satisfaction varies with different types of individuals, ranging from job security and structure for individuals having fairly concrete modes of thought, to factors such as social contact and esteem with more abstract individuals.

Within the educational context, Claunch (1964) has shown that cognitively abstract students perform significantly better than cognitively concrete individuals on a complex (essay) task, while/....

while there is no significant difference on a multiple-choice task. Similarly, Pohl and Pervin (1968) show that cognitively simple students do significantly better than cognitively complex people in Engineering, while the reverse relationship holds for students in the Social Sciences and Humanities.

Thus it would appear that the Humanities and the Social Sciences, or what we have termed in this thesis the arts, given their weaker tendencies toward a cumulative, cohesive structure, their lack of a "paradigm", and their descriptive nature, offer more opportunities for incongruity and contradiction and demand a greater degree of subjectivity and selection. Within this general framework of a "fit" between the individual and his environment, we should anticipate the results obtained by Hudson (1967, 1970) and credence is given to his argument (1970) that

"Convergers will tend to plump for those routes through the academic system in which the weight of accepted authority is the greatest - Mathematics, Physical Science, Classics; divergers, those in which this pressure is least. What is alluring to the converger (and repugnant to the diverger) about the exact disciplines is their exactitude. They are systems of thought from which both muddle and emotion have been removed.... while for the diverger, it is not only the emotional connotations of the arts that render them so attractive, but also their imprecision." (p16)

If we now go beyond Hudson's view that it is the individual's convergence or divergence that determines his area of interest and invoke our characterisation of divergers and convergers in terms of their structural simplicity or complexity, we can see

how/....

how a theory of a "fit" or match can account for the differential preference for the arts or sciences by the divergers and the convergers respectively. The structures of subject area and cognitive apparatus can both be seen to vary along dimensions of simplicity and complexity and we can therefore reasonably expect the "simple" individuals to be drawn to "simple" tasks and the "complex" individuals to "complex" tasks.

## IX THE HYPOTHESIS

In view of these arguments, it is thus hypothesised that:-

1) Scholars who are rated as cognitively complex will express a preference for the arts subjects and cognitively simple individuals will tend to prefer the sciences.

and

2) A "fit" between the individual and the requirements of the task will manifest itself in a level of performance that is higher than when this "fit" is lacking.

Thus it is predicted that simple individuals will prefer and achieve higher in the sciences, while cognitively complex people will prefer and achieve higher in the arts.



## X METHOD

The aim of this study, then, was to test the hypothesis that there is a relationship between the individual's level of integrative complexity and preference for the arts or science subjects, and secondly to determine the effect, if any, of this complexity on the level of achievement within these two subject areas. In order to do this, a paragraph completion test designed by Harvey (See e.g. 1966) was administered to 252 school boys in their final (matriculation) year when the boys were in the region of seventeen and eighteen years old. Intelligence measures were obtained from school records and subject preference was obtained from each of the boys. Performance measures in the form of matriculation examination results were subsequently obtained for the sample from the Natal Education Department at the end of the academic year. This examination is a public school leaving and university entrance examination held under the aegis of the State educational authority, and as such provides as objective a criterion of academic performance as is possible in any educational system.

### 1 Sample

The sample (n=252) was drawn from seven of the nine state controlled English-medium Boys' High Schools in the Durban, Natal area, (i.e. no co-educational mixed senior/junior schools and no Afrikaans or parallel-medium schools). As such the sample is fairly representative of all White English-speaking socio-economic levels in and around Durban, although no attempt was made at an exact representation. If any bias is present, it is in the direction of over-

representation by the lower S.E.S. levels. This could possibly affect the proportions of the different complexity levels found in the sample, although the proportions in this study do not differ greatly from those reported elsewhere (e.g. Harvey et al 1966). Subjects were drawn from the top and middle ability ranges in their school leaving (12<sup>th</sup>) year of school and were group tested one class at a time (approx. 20 per class depending on school and class). All subjects tested were from the Advanced (A) Stream. (Until very recently pupils were graded at the sixth grade level at  $\pm$  13 years of age and assigned to to the A stream which is an University entrance requirement, or to the Ordinary (O) Stream, a more practically oriented, less academic course. About 70% of school children were assigned to the A-Stream.)

## 2 Scoring

In this study, Harvey's This-I-believe Test was used for measuring cognitive complexity, although for obvious reasons not all of the referents used by Harvey were considered appropriate for use in local conditions - for example, Harvey's measure of ethnocentrism "the American way of life" has no ego-involving counterpart in South Africa as a result of different social emphases and socialisation patterns - at least as far as the English-speaking sector is concerned. (South Africa's white population is approximately 45% English-speaking and 55% Afrikaans-speaking. Social patterns differ to a certain extent, with the English sector less nationalistic in outlook and more liberal than the Afrikaans sector, with less emphasis on the obedience of authority and on religious attendance and belief.) On the other hand, authority situations are/....

are ego-involving as a result of educational and general social climates in South Africa, and hence the referents used were designed to tap these, as well as affiliation to group values. The items used, in order of presentation, were war, modern art, religion, people, politicians, committing suicide, hippies and telling lies. Instructions were identical to those used by Harvey.

Combined with the response booklet, and occurring before the instructions, was a page on which the scholars were asked to indicate their favourite, second favourite and least favoured subjects studied at school. I.Q. scores, verbal, non-verbal and total, were obtained from the scholars' record cards. In nearly all instances, I.Q.'s had been measured within the last three years and most had used the New South African Group Test. Where two or more sets of results were present, the highest set was taken.

Public Matriculation Examination results were obtained for the majority of the sample.

Scoring was done "blind", i.e. each response booklet was numbered and scoring for complexity was done independent of any knowledge of preference or intelligence level. Moreover, response protocols from the various schools of different background and S.E.S. level were randomised during scoring in order to exclude or minimise the possibility of localised range distortion as a result of large numbers of fairly similar results from one school or S.E.S. level being scored consecutively.

#### a) Level of Cognitive Complexity

Scoring of the responses for complexity was done in two ways.

Initially/....

Initially an overall evaluation was done in line with Harvey's theoretical framework and the individuals assigned to one of the four systems. However it was found that scorer reliability was fairly low (.50s) when response sheets were randomly retested by inserted scored responses back into the pile being scored. The time factor involved in scoring 250 subjects probably accounts for much of this variance, as well as the fact that this was very early in the author's scoring history. Although Greaves (1971a) reports reliabilities as high as .90, he does point out that the semi-projective nature of the test does require thorough familiarity with Conceptual Systems Theory and a certain amount of training.

As a result of the low reliability obtained, and in the absence of any possibility of training, a second approach to the scoring was instigated. Returning to the literature, four dimensions were isolated in terms of which it was felt all systems could be adequately characterised. Briefly these factors were:-

- I Degree of absoluteness and evaluativeness shown in judgements.
- II Dependence on authority, i.e. adherence to group norms, religious observance, etc.
- III Need for structure or the tolerance of apparent disorder.
- IV Positive or negative dependence of, and relation to, the generalised "other".

These factors were weighted on a five point scale ranging from +2 to -2 as a function of the intensity and direction of each of the four dimensions. A return to the literature and to Harvey's description of the characteristics which typify each of the four systems (See e.g. Harvey and Felknor 1970) served to establish typical "factor" profiles for each of the systems.

Table 1 "Factor" Profiles

	I	"Factor" II	III	IV
	Absolute Evaluative Concrete	Authority/ Group Dependent	Need for Structure	Need for the "other"
	-	-	-	-
C O N S C I E N T I A L	1	-2	-2	-2
	2	-1	-2	+2
	3	+1	+1	-2
	4	+2	0	+1
	+ Relative No Value Judgements Abstract	+ Authority Rejecting O= Independ- dent	+ Welcomes "Ambi- valence	+ Hostile Unco-oper ative

From Table 1 it can thus be seen that a System 1 individual will be highly absolute, evaluative and concrete in his thinking, authority orientated and has a high need for order and for social approval.

The System 2 person on the other hand, while he is as absolute and evaluative as the System 1 individual, rejects authority and is hostile and unco-operative, needing at the same time a highly structured environment. The System 3 person can be seen to be fairly relative in his judgements, but because of his need for social approval - a need to be popular and to have friends - he tends to relate to peer and group norms and to conform. His cognitive structure does allow a certain degree of ambiguity to be tolerated. The System 4 individual is relative in his judgements, non-/. ....

non-evaluative and balanced in his decisions, though this independence does sometimes make him appear unco-operative and even hostile.

Response protocols were thus scored in terms of the relative strength of these four factors and assigned to the four levels of complexity by matching score profiles with those in Table 1. Both Harvey (1966) and Greaves (1971) admit the possibility of transition stages between each of these four systems, in that an individual may perhaps be more complex in some cognitive domains than in others. Greaves goes even further by suggesting that, because of the strong negativity associated with System 2 responses, an individual can progress directly from System 1 to System 3 and that as a result System 1/System 3 transitions are possible. (In what follows, the following notation will be used: the symbols 1, 2, 3, 4, will stand for Systems or Levels 1, 2, 3, 4 respectively. Transitions will be designated thus: 2-3 will be a transition between levels 2 and 3 but nearer to 2 than to 3. Similarly level 3-2 is also a transition between level 2 and 3, but nearer level 3 than level 2.) As a result, then, of Harvey's and Greaves suggestions, the following thirteen systems or transitions are possible: -1, 1, 1-2, 2-1, 2, 2-3, 3-2, 3, 3-4, 4, and 1-3, 3-1. As a result of these considerations, the original 4x4 matrix was expanded to yield an enlarged profile system.

Table 2 Enlarged Profile System.

Table 2

"FACTOR"

	I	II	III	IV
-1	-2	-2	-2	-2
1	-2	-2	-2	-1
1-2	-2	-1	-2	-1
2-1	-2	+1	-2	+1
2	-2	+2	-2	+2
2-3	-1	+1	-1	+1
3-2	0	-1	0	-1
3	+1	-1	+1	-2
3-4	+1	-1	+1	0
4-3	+1	0	+1	0
4	+2	0	+2	+1
1-3	-1	-1	-1	-1
3-1	+1	-1	0	-1

Individuals were then scored in terms of these 4 'factors' and assigned on the basis of their factor profile to one of these 13 levels on the basis of best fit. Using this method a scorer reliability approaching .90 was achieved, which in comparison with the/....

the low .50 obtained initially made this longer method seem more desirable. In addition, a correlation of .75 was found between this and the more usual scoring method.

Scoring, as we noted above, was done blind, each response protocol being assigned a code number and all information being entered onto a master sheet. Scoring was done entirely by the author, though a relatively small ( $n=50$ ) was retested by a colleague, yielding an interscorer reliability of .43. In the light of the fact that this colleague was the only person with conceptual systems theory experience in the department meant that he alone was able to assist, even though he had never rated subjects previously. Thus it is felt that the tester reliability of .90 achieved during "blind" retesting is perhaps more important than the intertester reliability of .43.

It was felt, however, that the discrimination of individuals into thirteen levels is finer than the investigation warrants (or accuracy permits?) and so these thirteen levels were reduced to six as shown in ascending order of complexity in Table 3.

Table 3 Six Levels of Complexity Used.



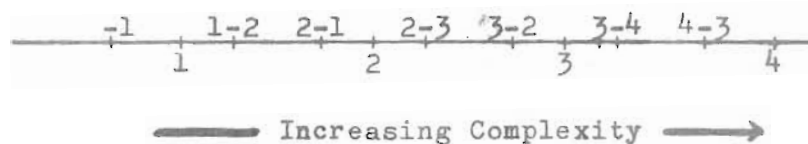
Table 3 Six Levels of Complexity Used.

Levels Used	Levels Derived from "Factors"
1	-1, <u>1</u>
2	<u>1-2</u> , <u>1-3</u>
3	<u>2-1</u> , <u>2</u> , <u>2-3</u>
4	<u>3-1</u> , <u>3-2</u>
5	<u>3</u> , <u>3-4</u>
6	<u>4-3</u> , <u>4</u>

As can be seen from Table 3, these six levels are roughly equivalent to Harvey's four conceptual levels with the intermediary or "nodal" levels 1-2, 1-3 forming one new level and 3-2, 3-1 forming the other transitory group.

In order to understand how transition levels between levels 1 and 3 are possible while yet keeping the linearity of complexity, we refer now to Diagrams 1 and 2

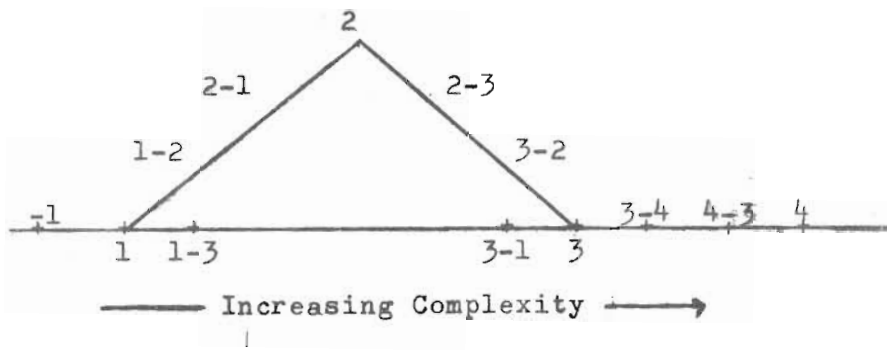
Diagram 1 Harvey's Systems.



Note that although transition levels between "neighbouring" levels are possible, transitions between levels 1 and 3 are ruled out. If we agree with Greaves (1971) that the strong negativity displayed by the System 2 individual in his social and interpersonal relationships is not a necessary stage in the evolution of a complex cognitive/....

cognitive structure, then Diagram 1 is not adequate. Diagram 2 shows how the 1-3 transitions are possible, while maintaining linearity.

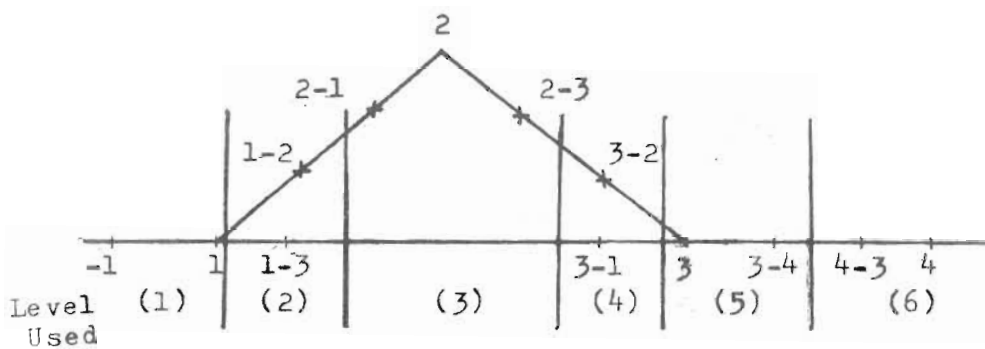
Diagram 2 Greave's System.



Note that 1-3 transitions are now possible, while the overall linearity is preserved.

Diagram 3 shows the structural levels used in this study. (See Table 3.)

Diagram 3 Levels Used.



Using this method, the responses of the sample of 252 school-boys were rated and the individuals assigned to one of the six complexity levels. From Table 3 and Diagram 3 it can be seen that the levels 1, 2 and 3 as used by this author are associated with systems 1 and 2 of Harvey, while levels 4, 5 and 6 are essentially the same as Harvey's Systems 3 and 4. On the basis of this equation, levels 1, 2 and 3, as used in this study, will be regarded as cognitively simple, and levels 4, 5 and 6 will be regarded as cognitively complex.

b) Measures of Preference.

In order to quantify subject preference configurations along an arts/science continuum for the purposes of correlation, the following scheme was adopted:

Arts subjects (which following Hudson 1967, were Literature, Modern Languages, History and the Graphic Arts) were given a weighting of +2 when they appeared as subject most favoured, a weighting of +1 when they were given as second most favoured, and -2 when they were chosen as the subject least favoured.

Science subjects (among which Hudson lists Physics, Chemistry, Mathematics, Physical Science and note Latin) were loaded in the opposite direction: -2 when they were given as most favoured (1F), -1 when given as second favourite subject (2F), and +2 when given as least favoured subject (LF).

Subjects that were strictly neither arts nor science subjects (e.g. commercial subjects, geometrical or technical drawing, and note biology) were scored 0.

Totalling/....

Totalling these loadings yielded a score spread from +5 - i.e. with an arts subject most preferred, an arts subject second most favoured, and a science subject least preferred +2 +1 +2 - to -5 (1F = science, 2F = science and LF = arts -2 -1 -2). This spread was then ranked from 1 to 11, reflecting a decrease in arts preference and a corresponding increase in science orientation. This is shown in Table 4

Table 4     Calculation of Preference

1F	2F	LF	SCORE	RANK
A	A	S	+2+1+2 = 5	1
A	O	S	+2 0+2 = 4	2
A	A	O	+2+1·0 = 3	3
<hr/>				
A	O	A	+2 0-2 = 0	) ) 6
O	O	O	0 0 0 = 0	
S	O	S	-2 0+2 = 0	
<hr/>				
S	S	O	-2-1 0 = -3	9
S	O	A	-2 0-2 = -4	10
S	S	S	-2-1-2 = -5	11

It can be seen from this table that it is assumed that a preference for one or other type of subject implies a non-preference for the alternative. Theoretically this is predicted by the individual/environment "fit" model. Analysis of experimental data from this study serves to justify this assumption. An inspection of Tables 5 and 6 below shows a significant  $X^2$  in the assumed direction for both the cognitively simple and the complex groups, although this would seem to be more true of the simple than the complex.

### c) Measures of Achievement

As indicated above, achievement measures for the sample were in the form of results from the public matriculation examination. Results were obtained from the Natal Education Department and consisted of the marks obtained by the scholars in each of their six or seven examination subjects. In all cases these marks are out of a maximum of 300, the only exception being the pupil's main language which is marked out of 400. (Both official languages, English and Afrikaans are compulsory for all pupils throughout school, although at different levels.) For the purpose of direct comparison of these results, the main language (for the sample this was English) marks were reduced pro rata to bring them into line with the maximum in other subjects, i.e. 300.

Means were calculated for the arts and science groups of subjects. In most cases at least two subjects in each group were used, often more. In only two or three cases was only one science or art subject mark available.

## XI RESULTS

### 1 Preference

Before we consider the major hypothesis, it is perhaps necessary to evaluate the scoring procedure, especially with regard to the preference data. Under Scoring above, it was assumed that a preference for one subject area implied a non-preference of the alternative arts or science, i.e. to be arts orientated meant that an arts subject was given as both favoured and second favoured subject and science given as least favoured. It is necessary to explore this assumption for if it is invalid, any results obtained using the preference data will be an artefact.

An analysis of the response protocols yielded data which are summarised in Tables 5, 6, 7 and 8.

Table 5      Subject Preferences of the Cognitively Simple

	(1) Most Favoured 1F	(2) Second Favourite 2F	(3) Either 1F or 2F	(4) Least Favoured LF
Science	56	71	98	47
Arts	30	41	60	88

Using data from columns 1F, 2F and LF, ( (1);(2)&(4) )  
 $X^2 = 11.28$  which is significant ( $p < .005$  2 df). Using data from  
columns 1F or 2F (3) and LF (4)  $X^2 = 21.17$  ( $p < .001$  1 df).

It can thus be seen in Table 5 that for the cognitively simple individuals ( $n = 150$ ) there is a highly significant tendency for

the/....

the sciences to be preferred and for the arts to be least preferred.

Table 6 shows a similar relationship with the cognitively complex.

Table 6 Subject Preferences of the Cognitively Complex

	(1) Most Favoured 1F	(2) Second Favourite 2F	(3) Either 1F or 2F	(4) Least Favoured LF
Science	31	28	46	48
Arts	46	58	76	45

Using data from columns 1F, 2F and LF (cols 1,2,4),  $X^2 = 6.78$  ( $p < .05$  2df) and using data in columns 1F or 2F (3) and LF (4),  $X^2 = 4.17$  ( $p < .05$  1 df).

Thus, although the data in Table 6 are significant, this is at the lower .05 level. This arises, it can be argued, from the fact that the complex scholars show a preference for the arts but non-preference for the arts and the sciences is about equal. This can be supported on theoretical grounds if we argue that for the cognitively simple individuals, preference and non-preference will be directly related, while with the complex persons this relationship will be confounded by other factors.

From Tables 5 and 6 it can be seen that the assumption that preference for one subject area implies a non-preference of the other/....

other is supported. Note however the proviso that this appears to be more characteristic of the cognitively simple than it does of the complex. Because the data in Tables 5 and 6 are for the most part significant at the .05 level, it will be necessary to treat the preference scores with caution and we must therefore look at the hypotheses of this study in terms of preference for individual subjects as well as in terms of preference scores.

Bearing in mind the limitations just noted, we must now evaluate the hypothesis that subject preference is related to structural complexity, and that an increase in arts orientation is correlated with an increase in complexity.

a) Firstly, combining data from Tables 5 and 6 yields Table 7 in which the differential preference for the two different domains of knowledge by the cognitively simple and complex individuals is shown.

Table 7 Differential Preference by Simple and Complex Persons

Subject given as 1F and/or 2F	Simple	Complex
Science	98	46
Arts	60	76

$$X^2 = 15.34 \quad (p < .001 \text{ 1 df})$$

Similarly, Table 8 gives a breakdown of the least favoured subjects.

Table 8/....



Table 8 Differential Non-preference of Simple and Complex Persons

Least Favoured Subject LF	Simple	Complex
Science	47	48
Arts	88	45

$$\chi^2 = 6.00 \quad (p \gg .02 \text{ 1 df})$$

From Tables 7 and 8 it can be seen that the predicted relationship is still evident, and it would appear that the quantification of the preference data has not introduced any artefacts into the study.

b) Correlation of preference score (ranging from 1 to 11, arts to science) with complexity score (ranging from 1 to 6, simple to complex) yields a significant product-moment ( $r = -.2133$ ,  $p \leq .01$  251 df). The effect of intelligence (which correlates .2848 with preference and .1676 with complexity) serves to reduce the correlation. By partialling out the effects of intelligence (using formula

$$r_{12.3} = \frac{r_{12} - r_{13}r_{23}}{(1-r_{13})(1-r_{23})} \quad (\text{See G\ddot{u}ilford 1956 } \quad (p316))$$

the magnitude of the correlation was increased to .2787 which is significant beyond .001 (251 df).

c) Sorting the data in terms of complexity and preference into a 2 X 3 matrix (2 complexity, 3 preference) yielded a highly significant chi-square. This is given in Table 9.

Table 9/....

Table 9 Preference vs Complexity

	Cog. Simple 1 - 3	Cog. Complex 4 - 6	n
Arts Pref. 1 - 3	24	40	64
'Mixed' Pref. 4 - 8	55	34	89
Science Pref. 9 - 11	71	28	99
n	150	102	252

$$\chi^2 = 19.19 \quad (p < .001 \text{ 2 df})$$

At this point the results of the public matriculation and school-leaving examination written by the pupils, the Natal Senior Certificate Examination were obtained for 226 of the original sample of 252 - the remaining 26 no having written, or having written at the more practical "O"-level. From this point on, therefore, the analysis and discussion of the data will be confined to this smaller sample.

Analysis of the smaller sample in terms of complexity and preference yielded, as would be expected, results very similar to those in Table 9.

Table 10/....

Table 10 Complexity x Preference (Reduced Sample)

	Cog. Simple 1 - 3	Cog. Complex 4 - 6	n
Arts Pref 1 - 3	21	34	55
"Mixed" Pref 4 - 8	45	34	79
Science Pref 9 - 11	67	25	92
n	133	93	226

$$\chi^2 = 18.93 \quad (p < .001 \quad 2 \text{ df})$$

Thus it is felt that the first part of the hypothesis has been supported by the data and that satisfaction as expressed by preference for a certain type of material relates to characteristics of the individuals cognitive structure. More specifically, it is felt that the data supports the contention that cognitively simple individuals are drawn to the sciences and that the complex individuals prefer the arts.

## 11 Performance

As noted above, the results of 226 of the original 252 subjects were obtained from the matriculation examination written at the end of 1972. The examination was the Natal Senior Certificate, a public examination written under the auspices of the Natal Education Department.\*

In this examination all candidates are required to take the two languages English and Afrikaans, one as a home language and the other as a second language. For this sample the home language was English. In addition to these two languages, at least one of the sciences is compulsory. The balance of the six (sometimes seven) examination subjects is constructed in most combinations from the whole range of arts, science and "other" subjects as described above depending on school and course chosen. All subjects have a maximum of 300 marks, except the home language which has a maximum of 400. Mean arts and science marks were calculated for the sample, and expressed as a score based on a maximum of 300. For this purpose the English mark was reduced pro rata to 300.

\*The author expresses his thanks to Dr Hosking and the Natal Education Department for making these results available.

In looking at the examination results of the sample, it was apparent that, although mean arts and science marks did not differ significantly, the variances of the two sets of marks were different with the science marks extending some 10% or 30 marks beyond those of the arts at both ends of the scale. Distribution characteristics are tabled in Table 11.

Table 11 Parameters of Examination Results (Marks/300)

	Science	Arts
Mean	158.79	165.70
Median	149.32	163.27
Mode	169.50	164.00
Range	66.00- 273.00	91.00- 237.00
Variance	2369.26	1126.91
Standard Deviation	48.68	33.57
N	226	226

A comparison of these variances yielded a  $t=10.05$  which is significant at the .001 level. (For the use of the t-test here, see Bruning and Klintz 1968 p109.)

Note also the negative skewness of the science distribution as evidenced by the discrepancies between mean, median and mode.

## 1 Achievement and Complexity

The hypothesis to be tested here is that, as a result of a match or "fit" between the individual and the task, achievement level in the two subject domains will vary as a function of the individual's complexity level. More specifically, it predicted that the cognitively complex will achieve higher than the simple in the arts, but that the cognitively simple would perform better in the sciences. Tables 12 and 13 analyses these predictions.

Table 12 Achievement x Complexity

	Simple	Complex	t	Sig
Art Mark	161.03	172.39	3.48	.001
Science Mark	156.88	161.51	0.94	N/S
n	133	93		

In order compare the data with a later table, deviations about the two means were calculated, yielding Table 13.

Table 13 Deviation about Means x Complexity

	Mean	Simple	Complex
Art Mark	165.70	-4.67	+6.69
Science Mark	158.79	-1.91	+2.72

Tables 12 and 13 show that the second part of the hypothesis is supported to a certain extent - as predicted, complex individuals score significantly higher than simple individuals in the arts subjects.

For/....

For science achievement, however, level of complexity makes no significant difference, i.e. the complex individual does as well as the simple one. This is, of course, counter to the hypothesis.

The evidence suggests that in the complex arts task, the level of complexity of the individual is an important determinant of success, whereas in the sciences, the simple and the complex achieve equally well. In other words, the complex individual is equally at home in both complex and simple tasks (though he may prefer the more complex situation - See Tables 9 and 10) while the simple person both prefers and achieves higher in the sciences - a simple task.

This would seem to be an important modification of the hypothesis. However, because of the different natures of the distributions of the two sets of marks (Table 11), it is felt that the results in Tables 12 and 13 should be treated with caution and that particular account should be taken of the possible role of intelligence in these results. In order to minimise any effect of intelligence all marks, arts and science, were adjusted by the degree to which they correlated with I.Q. - i.e. .588 for science and .497 for arts.

Results of this adjustment are shown in Table 14 and should be compared directly with Table 13.

Table 14 Achievement (-Adjusted) x Complexity

	Simple	Complex
Art Mark Deviation about Mean	-2.89	4.14
Science Mark Deviation about Mean	+1.71	-1.70

Although variances were not calculated on this data and hence no t-test could be carried out, a similar pattern to that in Table 12 emerges. Visual inspection would suggest that the arts marks differ significantly while the science marks do not. Note that this I.Q. adjustment does not affect the the dominance of the complex group in the arts subjects but that it is reversed in the case of the science marks. Although this does not appear to be a significant result, it does point to the differential contribution of the I.Q. to the achievement level in the two subject domains - a point discussed in more detail below.

On the basis of the results just presented, it is felt that the second part of the hypothesis is supported and that a "fit" between the individual's cognitive characteristics and the demands of the task results in a raised level of achievement. The data do, however, suggest that while cognitively simple individuals achieve highest in the simple tasks, the complex individual copes equally well in the simple and complex tasks - an important modification to the hypothesis. Although the concept of a "fit" remains important, the data would suggest that while simple individuals are "fitted" to the simple tasks, complex people are "fitted" to both types of task, the simple and the complex.

It may perhaps be argued that this interpretation of the data is value-laden in that it suggests the superiority of the complex person who is equally at home in the simple and complex tasks over the individual who is simple and whose success is limited to

simple/....



simple tasks. An alternative construction of these results would be to deny the generality of the individual's complexity across all cognitive domains and to argue with Bieri (1961) that complexity refers solely to social situations. The argument would continue that the arts, as defined here encompassing the humanities, literature etc. are obviously concerned with social situations and that therefore performance and preference would naturally be a function of measured complexity. The sciences, on the other hand, would be relatively independent of this social complexity, and would perhaps be more closely related to intellectual ability. Credence is given to this view by Anderson, Gardiner and Flathman (In press) who demonstrate independent factors of interpersonal and intellective complexity. However, while Bieri et al (1966), Allard and Carlson (1963), Signell (1966), and others have all reported or argued for domain specificity with regard to complexity, Scott (1963), Crockett (1965) and Bannister and Mair (1968) argue for generality of complexity across all cognitive domains. Thus, although certain evidence for this second interpretation of the data is available, the issue is far from decided. However, the construction of these findings first put forward is supported by analogy to findings reported by Bernstein (e.g. 1971) with regard to the use of different language codes. Bernstein argues that individuals or groups of individuals differ in the language registers they have available, some habitually using a structurally simple or "restricted" language code, while others use a grammatically and logically more complex, or "elaborated", code. Of interest here is the fact that individuals who possess only the "restricted" language can respond only to "restricted" language usage. Individuals possess-

ing the/....

ing the "elaborated" language code, on the other hand, respond equally well to "restricted" and "elaborated" codes.

"Children socialised within middle-class and associated strata can be expected to possess both an elaborated and a restricted code, whilst children socialised within some sections of the working-class strata, particularly the lower working-class, can be expected to be limited to a restricted code." (Bernstein 1971 p136 Original emphasis)

Cazden (1966) in analysing a study by Cherry (1964) notes that

"while lower-class fifth graders had more trouble understanding middle-class peer speech than that of their own group, the decreased comprehension across social class lines was not reciprocal. The middle-class children understood lower-class peer speech as well as did the lower-class children." (p188 My emphasis)

Although one cannot move very easily from linguistic to cognitive structures, this is not in fact being attempted here. What is being suggested is merely that the complex necessarily incorporates the simple and that the ability to deal with the complex presupposes the ability (if not the desire) to deal with the simple, while the ability to deal with the simple does not entail the ability to deal with the complex (even where the desire is present). Bernstein (1971), Cazden (1966) and Cherry (1964) all show this to be true for language skills and we believe this is as true for cognitive functioning. Thus it is argued that the complex individual is competent to deal with both complex and simple phenomena, whereas the cognitively simple individual is limited to simple phenomena. This we believe is the meaning of the data in Tables 12, 13 and 14.

## ii Relative Performance

In order to explore the effects of complexity a little further it was decided to examine the relation of cognitive complexity to achievement attained in one subject area relative to the other, independent of the actual level obtained by the individual. In other words, the contribution of complexity to the direction or bias of performance must be examined. To accomplish this, the sample was divided into three groups on the basis of their relative performance, i.e. into an arts performance group in which arts achievement was greater than that in the sciences; a "mixed" performance group in which arts and science achievement was equal; and a science performance group in which science achievement was superior.

As a result of the different characteristics of the two mark distributions (Table 11), direct comparison of the two sets of results was, however, virtually impossible. Therefore, in order to effect the analysis, each set of results was divided into a number of steps, comparison taking place across steps rather than individually. This was done in two ways, neither of which yielded significant results.

### a) Segmentation of Score Ranges

Firstly, the two score ranges were segmented into fifteen equal steps and individual marks were assigned to one of these steps. Relative performance in the arts direction was interpreted as the arts mark being one complete step greater than the science mark, and vice versa for the science group. Marks within one step of each other/....

other were assigned to the "mixed" performance group. Analysis of the distribution of these three performance groups in terms of their measured complexity or simplicity yields Table 15.

Table 15 Performance X Complexity (Equal segmentation of score range)

	Simple	Complex
Arts Performance	42	40
Mixed Performance	59	36
Science Performance	32	17

This distribution is not significant using chi-squared.

b) Segmentation of Sample

Because of the non-significance of Table 15, a second approach was used, dividing the sample into fifteen equal units. Once again individual arts and science marks were assigned to one of these units and relative performance calculated. Using this second method, Table 16 was obtained.

Table 16 Performance X Complexity (Segmentation of Sample Method)

	Simple	Complex
Arts Performance	34	33
Mixed Performance	48	36
Science Performance	51	24

Once again, a chi-squared analysis proved non-significant, though a simple exclusion of the mixed performance category was significant at the .05 level (ldf). Little importance can

be/....

be attached to this statistic, however.

On the basis of Tables 15 and 16 we are forced to conclude that relative performance is unrelated to the individual's level of complexity

Why this should be so is puzzling, especially in the light of the absolute differences shown in Table 12. However, an inspection of Tables 15 and 16 suggests that the lack of significance can be most attributed to the large number of "simple" individuals who achieve highly in the arts relative to the sciences. When we look at the I.Q. figures (Tables 20 and 22 below) we see that this group has the lowest measured intelligence. It is therefore suggested that in the lower ability ranges of the sample success is greater in the arts than in the sciences. Given the looser structure of the arts and the greater subjectivity of assessment, it can be argued that pupils of lower intellectual ability would tend to do better in the arts than in the sciences. This is borne out by the negative skewness of the science mark distribution and the higher minimum mark in the arts. (See Table 11.)

### iii Preference and Performance

In view of the strong relationship between complexity and subject preference reported in Tables 9 and 10, it is of interest at this stage to examine the relation between expressed preference and academic achievement, with respect to both level and direction of achievement. As explained above under Scoring, preference determination was based on the configuration of responses given to questions/....

questions asking for favourite, second favoured, and least favoured school subjects. Responses were ranked from 1 to 11 as they moved from an arts to a science orientation. Subjects ranked 1 - 3 are, for the purposes of this study, deemed arts preferrers, from 4 - 8 as having "mixed" preference and 9 - 11 as having a science preference.

a) Preference and Level of Achievement

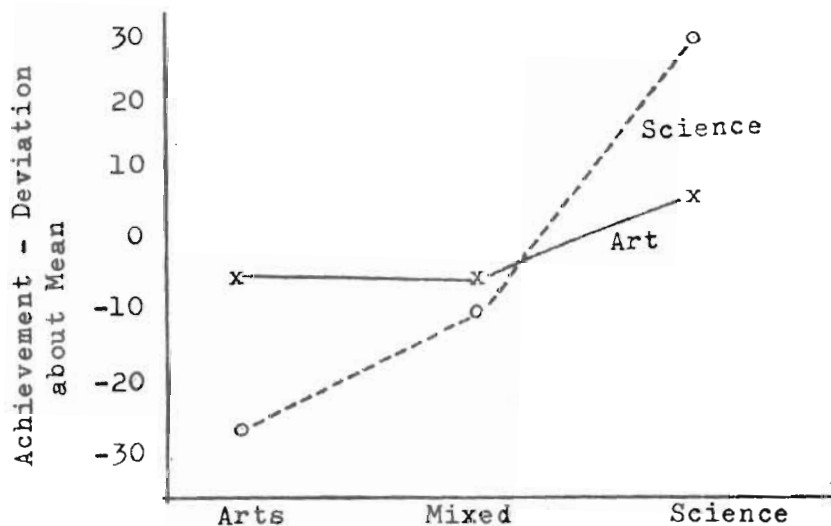
The differential effect of preference on achievement level is shown in Table 17 and Graph 1.

Table 17 Preference and Achievement

	Arts Mark	Science Mark
Arts Preference	160.65	130.31
Mixed Preference	159.05	144.95
Science Preference	170.90	187.65
Mean	165.70	158.79

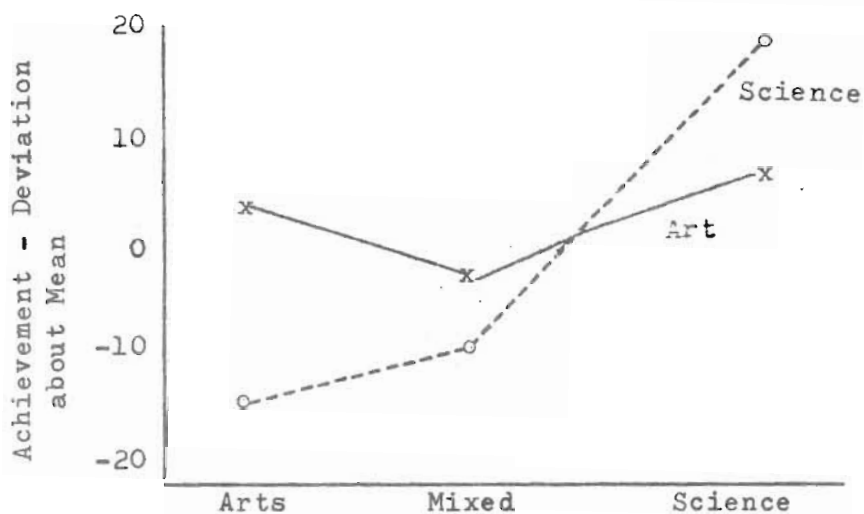
The data from Table 17 are presented graphically in Graph 1, expressed as score deviation about the two means.

Graph 1 Preference and Achievement (Unadjusted)



Note the relatively low gradient of the arts marks and the strong positive relationship between science preference and science achievement. This would suggest that success is a major determinant of satisfaction in the sciences. This is supported by a correlation of .494 between preference score and science mark, but only of .189 with arts mark. In order to exclude any distorting effects of intelligence variables, the marks were adjusted by their correlation with I.Q.. This yielded a result very similar to that in Graph 1, the only difference being a small decrease in score range. This data is presented in Graph 2.

Graph 2 Preference and Achievement (Linearly adjusted)



b) The Relation of Preference to Performance Direction

It is easy to predict a strong relationship between preference and performance - indeed it would be surprising to find that people did not enjoy what they were good at. This was found to be the case in this study. A 3 (preference) x 3 (performance) table yielded a highly significant chi squared result. See Table 18.

Table 18/....

Table 18 Preference X Performance<sup>+</sup>

	Arts Performance	Mixed Performance	Science Performance
Arts Preference	28	19	8
Mixed Preference	25	32	22
Science Preference	14	33	45

$$\chi^2 = 27.81 \text{ Sig } .001 \text{ 4df}$$

<sup>+</sup>Direction of Performance by sample segmentation method.

In accounting for this relationship between performance and preference, two outlooks are possible. Firstly, it can be argued that preference for a certain subject area will increase involvement, motivation, etc. culminating in a higher level of achievement. The problem then remains of accounting for the initial preference. Alternatively, it may be that satisfaction results from the level of success generally achieved in the task, i.e. one prefers the subject because one does well in it, rather than the reverse.

This second view, when applied to the preference findings, gives support to the idea that the scientist is essentially simple in cognitive structure - preference for the sciences is directly related to level of achievement, while for the arts, factors other than success contribute to satisfaction - a more complex situation. (Recall also the preference data discussed above (p 56) which suggested that the simple individual's preference and non-preference are strongly related, while this trend was less marked in the complex group.) Furthermore, because of the nature of the two subject areas, progress in the sciences is more readily perceived (the "rungs of the ladder" are more easily seen to have been climbed - cf./....



cf. Hajnal 1972 above). This greater feedback may be one of the factors contributing to the level of satisfaction experienced. It can be further argued that the cognitively simple would be more dependent on this immediate feedback than the complex person. This view is supported by Stuempfig and Maehr (1970), who show that complexity level and type of feedback has a marked effect on task persistence. In particular, they show that concrete (simple) subjects respond (by persisting at the task) to a greater extent in a situation where feedback is present. For the abstract (complex) subjects, the type of feedback appears to have little effect on persistence. It is not difficult to argue a relationship between persistence and satisfaction or preference.

Finally, evidence for this differential role of preference in the two subject areas is provided when we include the preference data in a polynomial regression for the prediction of arts and science marks. In the case of the science marks, predictability of achievement, level based solely on I.Q. data is .588, increasing to .675 on the inclusion of preference data. With the arts achievement, on the other hand, the regression co-efficient increase from .502 to .507 when preference data is included in the calculation.

All the evidence thus suggests that the individual's expressed preference is far more closely related to his success in the sciences than in the arts.

We have yet to look at the inter-relationship of intelligence level with the parameters we have been discussing in determining scholastic achievements. I.Q. measures verbal, non-verbal and total using the New South African Group Test, were available from the

record/

record cards of each member of the sample.

iv The Role of Intelligence.

As we have already seen, the single most important determinant of achievement level is general ability or intelligence which in this study correlates .497 with arts and .588 with science mark, (using Total I.Q.) This is within the limits reported by other researchers e.g. Cattell, Barton and Dielman (1972). Further analysis of preference and performance data in terms of I.Q. and complexity, yield Tables 19 and 20.

Table 19 Preference, I.Q. (Total) and Complexity.

	Simple	Complex
Arts Preference	III	II3
Mixed Preference	II5	I20
Science Preference	II9	I28

Table 20 Performance, \* I.Q. (Total) and Complexity.

	Simple	Complex
Arts Performance	II5	II7
Mixed Performance	II8	I2I
Science Performance	II8	I23

\*Direction of achievement - sample segmentation method (See above p69)

From these tables it would appear that I.Q. increases with complexity and with science orientation. This is supported by significant correlations between I.Q. and preference ( $r = .3117$   $p < .001$ ) and between I.Q. and complexity ( $r = .2071$   $p < .01$ ). See

Table/....

Table 23.

A breakdown of these Tables into Verbal and Non-verbal I.Q. components yields Tables 21 and 22.

Table 21 Preference, I.Q. (Verbal and Non-verbal) and Complexity

	Simple		Complex	
	VIQ	NVIQ	VIQ	NVIQ
Arts Preference	112	110	113	112
Mixed Preference	113	118	119	120
Science Preference	116	121	127	129

Table 22 Performance\*, I.Q. (Verbal and Non-verbal) and Complexity

	Simple		Complex	
	VIQ	NVIQ	VIQ	NVIQ
Arts Performance	113	115	119	114
Mixed Performance	114	120	118	122
Science Performance	114	120	120	123

\*Direction of performance by sample segmentation method. (See above p69)

The correlation of these I.Q. components with preference, complexity and achievement is shown in Table 23.

Table/23/.....

Table 23 Correlation of I.Q. with Preference and Complexity

	VIQ	NVIQ	TIQ
Preference (for science)	.2289*	.3543*	.3117*
Complexity	.2333*	.1204	.2071 <sup>+</sup>
Arts Achievement	-	-	.4971*
Science Achievement	-	-	.5883*

\*Sig. .001      <sup>+</sup>Sig. .01

Although the inter-relationships between these different measures are fairly complex, three principles would seem to emerge from Tables 19 - 23.

1. Higher absolute I.Q. relates to science orientation - as far as both preference and performance are concerned. Two possible reasons for this come to mind. Firstly, that the sciences attract the more intellectually able student. Secondly, as suggested by Hudson (1967, 1970), those cognitive styles most tapped by the I.Q. tests are the ones favoured by the science-oriented student - i.e. convergent thinking.
2. Relative I.Q. (i.e. the superiority of verbal or non-verbal component determines orientation - verbal I.Q. relating to arts and non-verbal to sciences. Taken in conjunction with 1. above, this would suggest that a low non-verbal ability results in a dislike of the sciences and the arts are thus preferred by "default". (c.f. Table 11 where minimum science mark is 10% lower than minimum arts mark resulting perhaps in a better self/....

self-image and greater experience of "success" in the arts and it is this which leads to the greater preference.)

3. Complexity relates to verbal I.Q.. This would suggest that the complexity measure taps some verbal factor, although Bieri (1961 p359) reports no significant relationship between cognitive complexity and verbal intelligence while Schroder et al. (1967) show that assessment of integrative complexity does not appear to be contaminated by verbal fluency as measured by length of sentence completions. On the other hand, as argued above, linguistic and cognitive structures have elements of similarity and probably derive from similar social and cultural sources. Therefore we would expect a certain degree of correlation. Further research into the commonalities of these two areas would be revealing.

The interaction of these three principles in the determination of area of ability is shown in Table 24.

Table 24 I.Q. in Relation to Other Parameters.

I.Q.			Conceptual Level	Preference & Performance
Verbal	Non-verbal	Total		
Low	Low	Low	Simple	Arts
Low	High	Medium	Simple	Science
High	Low	Medium	Complex	Arts
High	High	High	Complex	Science

Although this is an over simplification, it would seem to be a reasonable summary of the findings in relation to I.Q. factors.

## XIII SUMMARY AND IMPLICATIONS.

In summary then, this paper set out to demonstrate that as a result of a "fit" between task requirements and individual cognitive characteristics, individuals judged as cognitively complex would both prefer and achieve higher in the arts subjects while the cognitively simple individuals would be oriented towards the sciences. Cognitively complex individuals were shown to have wider ranging interests and information processing abilities than the simple individuals and that the arts were more complex than the sciences in terms of the number of variables acting in any one situation. This was seen to be related to the presence or absence of a "paradigm" in Kuhn's (1962) sense of the word. It was finally argued that the result of a "fit" or "match" between task and performer characteristics would result in an expression of satisfaction or preference and in a higher level of performance.

The data presented above was interpreted as showing quite unequivocally a relationship between structural complexity and preference. Tables 7, 9 and 10 all yielded chi-squared values significant beyond the .001 level and a correlation between preference and complexity though low was also significant at this level. Achievement in the sample's school leaving examination showed that while arts mark differed significantly with level of complexity, the science marks were not thus affected. This was interpreted as illustrating the ability of the complex individual to succeed in both simple and complex tasks (though perhaps preferring the complex) while the simple individual succeeds only in the simple tasks/....

tasks. I.Q. figures show an increasing science orientation with increasing ability, either because of the higher intellectual demands made by the sciences, or as Hudson (1967, 1970) suggests, because I.Q. tests favour those modes of thinking that are characteristic of the sciences, whether or not these or more "intelligent".

### Determinants of Performance

To summarise these results, the data of this study suggest:

1. Performance in academic subjects is for the largest part dependent on intellectual ability.
  - a) This is more true for the sciences than the arts.
  - b) This results perhaps from a "scientific" definition of intelligence and the construction of intelligence tests which tap those cognitive abilities important in the sciences.
2. Achievement in the arts depends to a certain degree on the complexity of the individual's cognitive structure. Science achievement is relatively independent of cognitive complexity.
  - a) This suggests that achievement in the complex includes achievement in the simple, while the reverse is not true. Linguistic parallels exist.
3. Performance in the sciences is closely related to stated preference. In the arts this is not the case.
  - a) This may be a function of feedback and "knowledge of results".
4. Preference is determined by cognitive complexity, science preferring simple, arts preferring complex.

A)/....

- a) Hence feedback will be more important for the (simple) scientist. (3A)
5. Intelligence components (verbal and non-verbal) relate differentially to arts and science performance .
- a) Where both I.Q. components are low, arts are preferred - by "default" it is suggested; i.e. failure in the arts is not so marked as in the sciences. (6. Below)
- b) Relatively high verbal I.Q. relates to arts achievement and preference, high non-verbal I.Q. to science achievement and preference.
- c) Where both I.Q. components are equally high, science is preferred.
- d) This suggests that the arts are preferred when non-verbal I.Q. is low.
6. The nature of the distributions of the two sets of marks and the significantly greater variance of the science marks suggest that both success and failure are easier to achieve or seen to be achieved, in the sciences than in the arts.
- a) Hence the findings in 3 a), 4 a), 5 a) and c).
7. Thus the picture emerges of two groups of individual's.
- a) Firstly, the low ability individual who does not achieve very highly in academic subjects. However because of the structure of the arts he tends to achieve more highly in these subjects than in the sciences, where greater emphasis is on knowledge of specifics. Despite this higher arts achievement, he may well prefer the sciences.

b)/....



b) Secondly, there is a group of individual's of medium to high intellectual ability. For these, achievement would appear to depend on complexity, the simpler individual's preferring and achieving in the sciences and the more complex individual's preferring the arts, but achieving equally well in both arts and sciences, I.Q. components becoming important, a dominance of the verbal component tending to push the individual into the arts, while a non-verbal dominance leading to the sciences.

If the data presented by this sample is truly characteristic of the population and if it is correctly interpreted, two things become apparent.

Firstly, by increasing level of complexity beyond a certain level, educationalists may be running the risk of "converting" many potential natural scientists away from the hardcore sciences - Physics, Chemistry, Mathematics, etc - in the direction of the humanities and arts, probably in fact into the social and biological sciences. This may or may not be a socially desirable development. However one should be aware of the fact that, while current educational theory of "creative freedom" in schools may enhance the creative potential and originality of the scientists it produces, there is an accompanying risk that fewer scientists will emerge and that those who do will be less "hardcore" in their outlook. Perhaps it is for this reason that a trend away from the sciences to the humanities and social sciences is discernible in numerous Universities. (See for example a report on Sussex University -

Times/....

Times Educational Supplement 16.3.73 p6)

A second aspect of these findings is the need to take into account in the educational situation the demands and characteristics of the pupils, the teachers and the material being taught.

Hirst (1969), for example, argues that;

"The internal logical characteristics of the distinct forms of knowledge and their relationships to each other, are likely to contain important principles that should govern the teaching of these areas."

(p153)

While recent research has concerned itself with the matching of teacher and pupil in their educative interaction, this study suggests the necessity of matching teaching method and material being taught. Several studies (e.g. Behr 1967, Davis 1967, Dougherty 1967) all suggest that in teaching mathematical ideas and operations, there is merit in matching the model of instruction with the special aptitudes of the students. Hunt and Hardt (1967) show that structured, highly organised programs are more effective for students of low conceptual level, whereas flexible approaches allowing high student autonomy produce greater gains for students of high conceptual level.

These studies and the findings reported above would therefore seem to suggest the necessity of adopting different teaching strategies for the arts and the sciences, and that these would have to vary as a function of the complexity level of the scholars. This is in fact probably done intuitively by most teachers but could be a fruitful area for future research. It is thus important to determine the interaction of teacher characteristics, teaching

method/....

method, subject characteristics and student conceptual level in order to maximise learning. Nor is it a simple matter of placing the pupil in a learning environment that is most congruent with his existing personality and cognitive structure, for as Harvey, Hunt and Schroder (1961) warn, such procedures simply promote arrestation and thereby defeat the process of growth and progress which should be a major goal of education. (p340)

The teacher is thus caught in a dilemma of having to capitalise in his teaching on existing aptitude and cognitive patterns while at the same time trying to modify that pattern and ensuring that arrestation of growth does not occur. According to Munsinger and Kessen (1964) this growth is best achieved when the material to be learned lies at the limit of his ability to deal with it, - less than this results in boredom, beyond this results in frustration.

"A person will most prefer environmental input which is at or near the limit of his ability to handle cognitive uncertainty.....A stimulus containing markedly more cognitive uncertainty than S's capacity, however novel it may be when defined against his experience, will not be preferred to less novel but capacity matching stimulation." (p 21)

Therefore in order to ensure the cognitive growth that is the aim of education, the characteristics of the pupil, the teacher, the subject being taught and the method of teaching must all be taken into account. Intellectual ability and scholastic achievement are not unitary concepts.

This study could perhaps have been extended in a number of ways.

Firstly, administration to the sample of a number of tests of cognitive style would have given empirical proof (or otherwise) of the theoretical position that these styles all reflect the single "umbrella" concept of cognitive complexity. In the light of Hudson's (1967) convergence/divergence argument from which this study has drawn so strongly, this is one style that ought to have been explored.

Secondly this study has not examined inter - and intra - school variables. One of the most important of these is social class. From the theory put forward and from numerous studies (e.g. Hunt and Dopyera 1966, Hess and Shipman 1965, Hunt and Hardt 1967) one would expect socio-economic-status to be strongly correlated with complexity level. Therefore, the distribution of the schools and the sample in terms of S.E.S. may be an important variable. This was not examined.

Another inter-school factor not controlled for is the fact that some schools are traditionally oriented in specific directions. For example, at least sixty pupils (i.e. almost 25% of the sample) came from an higher S.E.S. school with a strong science orientation. As a result, pressures other than cognitive would be exerted on the pupil to achieve in a given direction. Although it may be argued that such conformity is indicative of low complexity, this is not altogether satisfactory as our education system has very little room for non-conformity.

A third "school" factor not controlled for is the popularity of the teachers of the various subjects - an individual may state preference/....

preference for a school-subject simply because he likes the teacher. However, one trusts that this sort of factor is minimised in a large sample.

Thirdly, this study has been confined to a male sample. Indications are that a female sample would behave somewhat differently. (See e.g. Mischel and Mischel 1971 and Lesser 1971.) This sex variable would therefore have to be explored.

The greatest single criticism, however, that can be directed against this study resides in the complexity measure used. It can be argued that the whole investigation is tautological in that the instrument used to measure cognitive complexity was such that it would discriminate between the arts and science oriented individual's and that the findings of this study are as a result, artefactual. It could be argued that the linguistic nature of the test and the items used (Modern Art, Politics, People, etc.) could be expected to favour the linguistically-adept and socially-involved arts students. It would therefore come as no surprise to find that people who make complex statements about social stimuli are socially oriented. However, this does not explain their original involvement in, and preference for, the arts and humanities. At worst, therefore, this criticism means that a high level of complexity and social awareness derive from the same source. As such, the complexity test maintains its predictive validity and the thesis of individual/environment "fit" still obtains.

## CONCLUSION

Arguing from the cognitivist view-point that the individual actively interprets his environment, it was hypothesised that a "fit" or match between characteristics of the individual's cognitive structure and of his environment would express itself in satisfaction with and high achievement in that environment. It was argued that the numerous cognitive styles could be accounted for in terms of the complexity of the individual's cognitive structure. Having argued that the sciences differ from the arts and humanities in terms of the number of variables impinging on any one topic, it was hypothesised that cognitive simple subjects would be drawn to the sciences and more complex individuals to the arts.

Results indicated that while the simple subjects both preferred and achieved higher in the sciences, the complex subjects achieved equally highly in the arts and the sciences, though they preferred the more complex arts. This was interpreted as indicating the ability of complex individuals to achieve equally well in simple and complex tasks though preferring the complex environment while the simple subjects were restricted to simple tasks.

The implications of these findings to teaching and to a possible reduction in the number of scientists emerging from our schools as a result of more "democratic" and more complex teaching patterns were discussed. Finally, the study was evaluated and further research indicated.

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