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A STUDY OF SOME ASPECTS OF
CLASSIFICATION
AND GROUPING

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A thesis presented in partial fulfilment of the
requirements for an M.A. Paper. 1975.

A C K N O W L E D G E M E N T S

The author is indebted to all those who helped in many ways in the preparation of this thesis.

Professor C. Hill and Mr E. Archer of Massey University Education Department for their help in the design of the preliminary investigation on children's classification.

Professor G. Tate and Mrs N. Simpson of the Massey University Computer Staff for their help in the preparation and processing of data.

Mr S. Loveridge and the staff of Roslyn School, Mr W. Foster and the staff of Awapuni School, Mr Bonnevie and the staff of Intermediate School, and to those children who participated in the tests.

Mrs J. Burnett and Miss M. Webster of Palmerston North Teachers College, for their help in categorizing grouping behaviour.

Mr Ross Udy for his help with testing, data processing and photographic work. Mr K.J. Paintin of Palmerston North Teachers College for his help with printing.

Finally, the author is especially grateful to Dr D. McAlpine of Massey University Education Department for his patient help in supervising the work in progress.

ABSTRACT

This investigation is concerned with how children group objects and with the underlying rules they may use to categorize experience. The sample consisted of three hundred and twenty children with equal numbers of boys and girls in each group of eighty, five, eight, ten and twelve year olds. Subjects were given two free sorting tasks using attribute blocks and an array of everyday objects. Verbal explanations were recorded. Developmental trends were sought in terms of the numbers of groups formed (discrimination), criteria chosen as the basis for grouping, and the potency of stimulus material as a possible determinant of criteria. The differences in logical sorting, pattern making and figural arrangements were examined and also found to be age rather than sex related. Language responses showed increasing sophistication in criterial choice and in the ability to explain groupings.

Highly significant results were obtained showing age related trends for all groups. Younger subjects formed more groups which they were less able to explain than older children. Younger children showed more responses with partial logic and simple pairing of objects, and they also formed groups on the basis of perceptible (colour, shape, size), while older children used more functional criteria (use). Older subjects showed greater stability in logical grouping and formed fewer groups, each with more objects. Attribute blocks evoked more geometric pictorial and pattern making in younger children than did array materials. Significance was not found for any of the independent variables except age. These included sex, age, parental occupation, size of family, position in the family, pre-school and school attendance.

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INTRODUCTION - SOME PERSPECTIVES IN CLASSIFICATION

In investigating classification one is first concerned with how people group objects and then with the ways in which they categorize experience (Nixon 1971). Bruner (1966) defines a category as a rule for classifying objects as equivalent. He sees categorization as ordering and simplifying environmental complexity and reducing the necessity for constant learning. This permits us to see relationships and to make comparisons between classes of events, while at the same time it minimizes error, for it enables us to save time and energy in decision making. Sokal (1974) considers classification as the recognition of similarities in patterns of sensory input.

The present investigation is concerned with children's classificatory and grouping behaviour within the area of cognitive psychology. A number of developmental investigations on the formation of class concepts have been conducted over the years. Simple sorting tests have generally been employed with subjects required to match test materials or to freely sort them. Instructions are usually minimal to encourage free and spontaneous sorting. (See footnote.)

Thompson (1941) administered Vygotsky, Weigl Colour-form, and other tests to children aged from six to eleven years. She found that the younger children tended to see no objects that belonged together or to class objects together in concrete situations. The present investigation disagreed with these findings since 90% of the five year old subjects produced grouped material which included groups with at least two objects as belonging together. Thompson also reported that the older subjects formed more categories on an abstract basis. She observed a definite qualitative and quantitative change in the ability to handle abstractions between the age range of six to eight years and nine to eleven years.

Footnote:

A wide range of relevant research literature also emanates from clinical psychology, perceptual studies, behaviour and learning theory. Readers who are concerned with these aspects of classification are referred to the bibliography and to Appendix 2.

Reichard, Sneider & Rapaport (1944) tested 234 children aged between four and fourteen using Weigl's colour-form test. They noted three levels in the development of class concept linked with age. The first "concretistic" stage gave way to a functional stage at between eight and nine years when children demonstrated consistent classification based mainly on use. More mature conceptual classification developed at about eleven years of age. The present study (TABLE VIII) shows that object sorting (arrays) responses have increased from 3% in five year olds to 18% in eight year olds. It agrees also with the tendency to more mature conceptual classification in twelve year olds here demonstrated in their explanation of groups. Similar findings were noted by Sigel (1953). Sixty children aged seven, nine and eleven were required to sort arrays of environmental materials and pictures. Here chronological age, social class and mental ability were controlled. Explanations were required and the tester took account both of perceptual and linguistic response to the tasks. Sigel reported that younger children were more closely tied to the perceptual cues of the stimulus material. Subjects showed an increase in higher or conceptual classification and less dependence on earlier perceptual or mixed groupings with increased age. A notable feature of these tests was the amount of individual variation found within groups. More recently Nelson (1974) studying the natural language categories of five and eight year old children found that age changes appeared to be related to increasing articulation and hierarchical expansion of categories, and that both ages showed reliance on functional definition.

Annett (1959) studied 303 children aged between five and eleven years, and forty-two adults between eighteen and seventy-three years. Tests consisted of sorting sixteen cards depicting common environmental objects, and explanations were recorded. Annett isolated three developmental categories. (a) "Contiguity", in which objects are directly related as "going together". (b) "Similarities", in which objects are classified on the basis of shared similarities, and (c) "class name", which includes such generic terms as "household objects". Annett obtained over 200 different combinations of cards, half of which were unique.

While each type of sorting was present within each group, sortings showed a clear change in so far as the number of combinations reduced as age increased. While Annett's study demonstrated a progression in the development of logical thinking with age, some older adults resembled younger children in giving more enumeration and contiguity responses. This finding is in keeping with that of Denney (1972). Many children and adults used more than one method of explanation. Annett suggests that people may vary in the developmental stage reached, and that individuals may not develop all conceptual stages simultaneously. Evidence for this was also found by Lovell (1961) in classificatory tests where primary school and E.S.N. children were tested, each child receiving the full complement of five tests. Steiner (1975) also argues for less stage-age explanation for these tasks.

Vygotsky (1962) used blocks with letter symbols to study language and concept development. Each subject was given two sets of stimuli and some 300 children, adolescents and adults were tested. Vygotsky describes three basic phases, each divided into several stages of concept development. Firstly, the young child perceptually forms "syncretic heaps" with groupings at random or through contiguity in space. In the next "complexive" phase, the child no longer mistakes connections between his own impressions for connections between things, groups are now formed on the basis of shared similarities of attributes and the bonds between the components are concrete and factual. Objects are grouped on the basis of their participation in the same practical operation, or on their function. Diverse objects such as cups, saucers, plates = dishes. Hats, singlets, jumpers, socks = clothes.

Complexive thinking is made up of chain complexes, fluid complexes and pseudo complexes, all of which lack grouping consistency. In chain complexes "... an object included because of one of its attributes enters the complex not just as a carrier of that one trait but as an individual, with all of its attributes. Thus the single trait is not abstracted by the child from the rest". (P.64) Pseudo concepts develop next which lack the criteria of true logical grouping.

The final phase cited by Vygotsky is that of the true concept which begins to develop during adolescence when the primitive syncretic and complex forms of thinking gradually subside and true abstract thinking emerges. The conventional superordinate category emerges governed by logical (syntactical rules). Words enable us to abstract, synthesize and symbolize concepts. Vygotsky's theoretical construct is based on linguistic meaning.

Denney (1972a) attempted to replicate Vygotsky's tests but she was unable to observe developmental stages similar to those described by Vygotsky. Vygotsky's work is of particular interest because of his descriptions of syncretic heaps and chaining complexes which resemble grouping behaviour observed in this investigation. Why we may ask, did Denney achieve such inconclusive results in her replication study? The present investigation clearly showed examples of complexive sorting despite the use of different stimulus blocks.

Like Vygotsky, Bruner regards cognitive development as emphases rather than stages.

Bruner & Olver (1963), investigated equivalence formation in their research into concept formation and grouping strategies. The stimuli used in these experiments were card illustrations of a variety of familiar objects including such things as fruit and musical instruments. Bruner also described developmental sequences in his subjects, and established rules for grouping. "Firstly, the subject selects only a fraction of the properties available for grouping, and this achieves a reduction in load. Thus we may group oranges, apples, pears and bananas as fruit, while ignoring such attributes as colour, shape, or keeping quality. Such groupings always involve less than the sum of the discernible elements. The second grouping rule has the property of being generalizable, so that if more of the group were known, knowledge of the grouping rule would still permit one to regenerate the elements by relating them to prior known groupings. But simplicity and

reproducibility are not the only goals of the grouping process. Others include providing a basis for categorizing future objects and events relating previously established concepts, and moving ahead to new levels of conceptual activity".

More recently Muiyunder (1974) studied coding of random patterns in six and nine year old children and Bruner & Olver (1963) showed that imaginal systems worked better than verbal ones for spatial and shape organization of patterns.

Work in the development of equivalence formation was followed by an array of experiments designed to investigate cognitive growth. Bruner & Olver (1963) investigated changes in grouping from childhood to adulthood, which are produced by changes in the rules by which data from the world is transformed and organized. In experiments carried out to test the hypothesis of change, children of various ages were given diverse arrays of items presented sequentially but in a form progressively more diverse. The results indicated such equivalence grouping shows a gradual transition "from the association of items into complexive structures on the basis of diverse characteristics to the unification of items into superordinate structures based on a common characteristic ... the young child deals with the single characteristic or impression that is most vivid at the moment, usually a perceptible attribute of the object. Next the child develops a common attribute in terms of himself - how he can act upon the objects. Later the child places himself in a reciprocal relation to the objects (decentralization occurs)".

Olver & Rigney (1966) traced the development of equivalence in sixty subjects aged six, nine, eleven, thirteen, fifteen and eighteen years. They maintain that with enactive representation equivalence is based on a common rule in some action, while equivalence with Ikonic representation is more likely to be accomplished by grouping items according to perceptual kinship or likeness. With the achievement of symbolic representation, equivalence is expected to be governed by grammatical rules. Olver & Rigney reconsidered the issue of syntax equivalence raised by Vygotsky's

experiments. They distinguished three general groupings. Groupings are formed on the basis of perceptible attributes (colour, shape, size), functional attributes (i.e. by use), affective attributes (by emotional response), and linguistic convention (from an existing language term).

Different grouping strategies emerged. Superordinate concept formation occurs where items are grouped on the basis of one or more attributes common to them all, i.e. "they all made a noise". Complex formation is characterized by construction on the basis of several different attributes, none of which need be common to all items in the group. Finally, thematic groupings occur, and here construction is on the basis of several different attributes, there is co-occurrence of the items in a story or theme.

Degrees of inclusiveness in groupings were observed. Firstly, grouping was specific to each item. Next, some limited inclusion occurred, which yielded information about some members of the group, and which could be extended to meet new situations. Finally, fully inclusive grouping occurred which applied to all members of the groups.

The use of language was observed where nouns, verbs, adjectives etc. were used in forming groups. The linguistic framework was related directly to Bruner's taxonomy of perceptible, functional and affective bases. They concluded that with younger children, complex formation groups occurred where language was concerned with the perceptible properties of objects. Where superordinate groups were produced, the functional mode operated. Older children showed an increasing tendency for both complexes and superordinate complexes to be formed by the use of language in the functional mode. The shift from concentration on surface perceptible properties to the more embracing functional properties would seem to make possible the development of more efficient and simpler grouping strategies. Why, one may ask, did the present study show so few affective responses and thematic groupings when the rest of the findings agreed with those of Olver & Rigney?

Nelson (1974) studied the composition of natural language categories in five and eight year old children. Age changes occurred primarily as an increase in the number of responses given, and these appeared to be related to the increasing articulation and hierarchical expansion of categories. Both ages showed reliance on functional definitions of category memberships. What proportion of perceptible functional responses are to be found in five, eight, ten and twelve year old children in the present study?

Piaget bases his work on biological and logico-mathematical operations which he considers as models of cognitive structure, and he maintains that true classification involves operational understanding of the logic of classes as revealed in children's handling of hierarchical class structures. Psychologically, an operation can be described as an action which can be internalized and which is reversible.

Piaget made use of certain structures, notably the group, the lattice, and certain algebraic and topological structures. "Thus if Piaget says that classificatory behaviour of an eight year old demonstrates the presence of logical class addition, he means that children can demonstrate the same formal properties possessed by the logico-algebraic model i.e. reversibility, associativity, composition, tautology etc. He infers from the child's behaviour in classifying that the child's cognitive structure has similar properties". Flavell (1969) P. 169.

Inhelder & Piaget (1964) describe the results of a number of tests with 2159 children in which they used sorting and other test methods to study the operations of classification and seriation. Inhelder & Piaget (1964) describe three main stages in the development of classification. (1) Graphic collections as a first attempt to synthesize intension and extension. (2) Non-graphic collections as an additive classificatory structure. (3) Class inclusion and hierarchical classifications.

In describing graphic collections Piaget lists several phases which tend to overlap and which do not always appear in the same sequence. Firstly,

alignments, which are usually linear arrangements and may be continuous or discontinuous in their criteria. Do the alignments described by Piaget seem to resemble Vygotsky's "chain complexes"? Some of the arrangements observed in the present investigation seem to indicate that they do. e.g. Figures 19a and 19b. Next "collective objects" are described as two or three dimensional arrangements again with fluctuating criteria, and finally "complex objects", grouping based on genetical or situational content. These resemble some of the figural arrangements in the present study. Denney (1972a, 1972b) failed to replicate the work of Inhelder & Piaget in demonstrating alignments and other phases of non-graphic collections. At this stage, although the child may sometimes begin by sorting objects which are alike by putting them together one at a time on the basis of resemblance, he seems to have no recognition of the whole set. (See Figures 14a and 14b). Spatial proximity and other perceptual cues such as colour influence the arrangement at this stage. Grouping is still so unstable that although sorting by similarity of attributes may occur, logic is soon destroyed by the inclusion of a non-class.

Inhelder & Piaget's second phase in the development of classification is that of "non-graphic collections" in which objects are grouped by similarity alone. Four kinds of non-graphic collections are described. (a) A number of different groups are assembled, each on the basis of different criteria but which do not include all the blocks. These were observed in only one case in the present study (Figure 20). (b) Groups are again based on different criteria but here all the stimulus material is included. (c) All blocks are assembled into groups based on the same criterion. (d) Finally all groups are based on the same criterion and then further subdivided according to the same second criterion. Many instances of these kinds of sortings appeared in the present study but they occurred with considerable variation across ages. Although the child at this stage forms groups of objects on a similarity of attributes basis and tries to form groups within groups, the principle of class inclusion is not yet fully established. Children's groupings fail to fulfil the criterion of

classes at this stage because they lack the properties of comprehension and extension.

The child's ability to coordinate comprehension and extension, and hence to classify, depends upon the control of logical quantifiers "the", "some" and "all". i.e. All A are B, but only some B are A. $A^+ + A' = B$ provided A' is not an empty class.

Although the child may indeed recognize that the subclass A is included in class B, he cannot recognize that $A = B - A'$ and keep this A-B relation firmly in mind across all manner of changes including spatial distribution of class and subclass.

The act of categorization results in the grouping of objects according to one or more of the attributes which they have in common. Such grouping underlies the formation of classes. The development of the concept of class occupies a central position in Piaget's accounts of the development of logical thinking in middle childhood, since mathematical reasoning also consists of reasoning about classes and class membership.

Inhelder writes, "The affective operation of the child's concrete thinking and of the formal thinking of the adolescent constitute among themselves closed systems of which the most important characteristic is their reversibility ... Piaget distinguishes two forms of reversibility: inversion (negation) and reciprocity. At the level of concrete logical thought, negation applies to the classificatory operations, and reciprocity to those involving relations. While the thinking child of less than six years (in Switzerland at least) is still characterized by the absence of reversibility, from six to eleven years the child can already achieve in given situations, one or other, but not both, of these forms of reversibility". Furth (1969) P. 261.

A recent paper by Keating (1975) asks if the development of formal operations in fifth and seventh grade children is related to measured intelligence? He suggests a relationship between precocity in attaining formal operational thinking and high intelligence scores.

".... Those more able adolescents who come to handle formal and propositional operations use the two forms of reversibility simultaneously. These two sets of operations form an unitary system which corresponds to the model of the four transformations (I.R.N.C.) described by Piaget.

I = Identity	N = Negation	NR = C; CR = N
R = Reciprocity	C = Correlation	CN = R; NRC = I

This double reversibility confers a high degree of mobility and coherence upon formal thought". (ibid) Taylor (1971) criticizes the I.N.R.C. group lattice structure.

At the formal operations stage somewhere from eleven years onwards, the child is able to cope with hierarchical classification. With the development of the capacity to manipulate hierarchical ordering, the young person can now see a problem as a whole and see a multiplicity of viewpoints. His thinking is now "mobile", symbolic, and largely freed from perception. He can grasp and use several criteria for classification which enables him to formulate and systematically test hypotheses, and he is capable of understanding the calculus of propositions and of performing second order operations in logic.

Lovell et al (1961) repeated seven of Piaget's classification and three number experiments. These investigations were carried out in two parts and involved groups of fifty primary school children and varying numbers of E.S.N. pupils aged between nine and fifteen years. All subjects received each of the tests. Children in stage I showed no consistency in their actions and were unable to see and plan the next step (a finding in keeping with the present study). At stage II the beginning of a construction seemed to be remembered. Lovell's results confirmed the view of Piaget & Inhelder in the ability to achieve stage III (operational ability is achieved by primary school children at about the same time in addition of classes, multiplication of classes, visual seriation and multiple asymmetrical transitive relationships). Macnamara (1975) argues however, that Piaget's account of how children develop an understanding of number is erroneous. He contends that number

bears only an accidental relationship to a system for classifying objects and states also that seriation cannot serve as the basis for discriminating objects. Brainerd (1973) also challenged Piaget's findings since his own research indicated that transitivity was found to emerge before class inclusion.

From his second series of experiments, Lovell found that E.S.N. pupils differed in perceptual mode from other primary school children. This seemed to suggest that simple classificatory tasks do not greatly depend on language. The equivalence findings of Bruner et al (1966) in his studies of Mexican and Eskimo children with and without schooling, also suggest that the language and environmental training may have their affect on the perceptual and cognitive mode adopted by different groups.

Dodwell (1968), investigated classification behaviour using the model and applying scalar techniques, his findings were however inconclusive.

Other studies which have reinvestigated aspects of Piaget's classification work are those of Wohlwill (1968), Sigel (1971), Wohlwill & Lowe (1972), Brainerd (1974), Denney (1972b and Nixon (1971) (1973). Recently also Ahr & Youniss (1970) & Kahl et al (1974), Sheppard (1973) and Talensky (1974), investigated some facets of training and test procedures in classification and Drummond et al (1973) the issue of age and class inclusion. These various investigations have helped to demarcate the parameters of the theory, but despite the criticisms of methodology and stage theory, Piagetian descriptions of the sequence in stages of cognitive growth have withstood the barrage of research.

Several studies have appeared which seek to establish connections between grouping behaviour and cognitive style. Initial work in the area consisted of block-sorting Gardner (1953), card-matching Bruner & Tajfel (1961) Kagan (1963), and category width paper and pencil tests Pettigrew (1958). More recent work has centred around classification and cognitive - impulsivity Bjorklunk & Butler (1973), reflection-impulsivity and

logical classification, Panckhurst (1971), and problem solving strategies in reflective-impulsive children Ault (1973), Sigel & Kilberg (1973), Weiner & Berzonsky (1975).

Gardner & Schoen (1962) established a possible link between the function of few groups on an object sorting test (broad categorization) and creativity. Connections were sought between breadth of categorization and conceptual style. Kagan et al (1960) designated styles as being descriptive, categorical-inferential, and relational or as analytical and relational. A child with analytic cognitive style was found to group stimuli according to their similarities, whereas one demonstrating a non-analytic approach might grasp the same set of figures by affective criteria, "Those I like". With age, analytic responses tend to increase and relational to decrease. Analytic thinkers differentiate the stimulus environment and are better able to separate relevant from irrelevant fields. Non-analytic children are found to be more "field-dependent", more impulsive and more susceptible to immediate perceptual experiences. Witken et al (1962).

Wallach & Kogan (1965) asked what relationships might exist between the various categorizing and conceptualizing tasks. They found that correlations were generally low. They also found that conceptual style indices derived from object sorting revealed a significant sex difference in descriptive response. Witkin et al (1962) also demonstrated the consistent tendency of boys to analytic functioning in conceptualizing and not girls. Wallach & Kogan (1965) obtained a relationship between category breadth and creativity for girls but not for boys. Wallach & Kogan treat categorization as a problem in preference for narrow versus broad categories, and conceptualization as a matter of structural characteristics of the concepts employed when grouping or integrating diverse arrays of stimuli.

More recently, Panckhurst (1971) used matching-figure classification tests to study reflection-impulsivity in girls, which relates to Kagan's relational, analytic-descriptive, and inferential-categorical

cognitive style dimensions. Panckhurst points to developmental sequences which show increasing ability to make abstraction in classification tasks. She compares the classification work of Annett (1959), Inhelder & Piaget (1964) and Kagan, Moss & Sigel (1963, 1964).

Are there, one may ask, connections between the number of groups formed in an object-sorting test and the age and sex of subjects? Does the observed behaviour of some subjects who form few groups reflect equivalence range and is it also sex-related?

Conclusions

The larger studies of classification reviewed above have made extensive use of simple sorting tests. Such tests have been criticised on the grounds of artificiality, a charge which may be levelled at almost all test situations and which is inherent in their very nature. A more valid criticism is that such tests produce a great variety of responses, the wealth of which inevitably leads to subjectivity in interpretation and makes sound generalizations exceedingly difficult. Probably more serious in this area is the lack of standardization of either tests or procedures.

A variety of theoretical orientations have emerged with the researches outlined above. Some investigators have relied purely on observation for their results, Thompson (1941), Annett (1959); Some have created models, Piaget (1964), Bruner (1966), Vygotsky (1962) and the cognitive style theorists, while others again have followed existing models - Denney (1972), Lovell (1962), Sigel (1953) and Panckhurst (1971).

Particular theoretical views have also affected the issues of language and culture with regard to classification studies. It has been suggested that class concepts are less dependent on verbalization for their formation, Piaget (1964), Lovell (1962), Brainerd (1974); are largely shaped by language, Vygotsky (1962); or are strongly influenced by language, Bruner et al (1966). Price-Williams (1966), Bruner et al (1966) and DeLacey (1970, 1971), have variously compared groups of children living as food-gatherers or in a rural environment, and their

peers in school. Interpretations concerning the influence of language and the cultural milieu seem to suggest that the culture may modify classification performance by developing perceptual or intellectual skills in different ways for different groups.

Elementary classification, the discrimination of classes of objects on the basis of common features has been observed in quite young children, Stott (1961), Greenberg & Blue (1975).

Lovell et al (1962) showed that E.S.N. pupils tended to use tactile-kinesthetic perception to classify, while normal pupils relied more upon visual perception. More recently, Farnham - Diggory & Gregg (1975) showed that while form properties were more difficult for children than adults, these were more readily extracted and classified if children used familiar objects. Hale & Piper (1973) found that colour facilitates learning of stimulus material in classification, while Aiken & Williams (1975) described how a multiplicity of attributes were used to classify polygons. Issues relating to where discrimination ends and concept formation begins is a controversial subject, Kendler T. (1961), Ash (1975).

The most consistent finding from classification studies concerns the function of age in intellectual development. The issues of stages is less clear. Are sequential, overlapping or discrete stages present or are they partly a matter of interpretation? The concept of stages in the literature of classification provides a multiplicity of answers.

The research so far discussed raises a number of questions of interest to the present investigation. Most of the findings show a development from concrete or use criteria as the basis for groupings, through to more abstract criteria used in early adolescence. The present study is not designed to show the demarcation of stages in children's classificatory behaviour, but it is concerned to show changes with age in the cross-sectional samples of five, eight, ten and twelve year old children. This study uses different test materials and it is not intended to

replicate the work of Vygotsky, Bruner or Piaget. However, the groups which emerge are scrutinized for resemblances to those described by the cognitive development theorists. Grouping criteria are examined in terms of their perceptual and language properties and these are considered in relation to Bruner's thesis on equivalence sorting.

While Gardner (1953) observed equivalence range in his object sorting task as being related to the number of groups formed, the present investigation seeks to determine the generality of this phenomenon, its frequency with age, and whether it occurs more in boys than in girls, as the literature suggests. Thus the present study was devised to investigate classification within the broad areas of discrimination, preferred discriminatory mode, and criterial choice. Age, sex and some aspects of family background and schooling are also considered. Hypotheses to investigate, sample description and testing procedure, are presented in the next chapter.