

AN INVESTIGATION INTO THE OBJECT GROUPING BEHAVIOUR  
OF YOUNG CHILDREN FROM A LOW SOCIO-ECONOMIC BACKGROUND

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. by

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for the degree of Master of Arts in Psychology at the  
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TABLE OF CONTENTS

	<u>Page</u>
ACKNOWLEDGEMENTS	i
TABLE OF CONTENTS	iii
LIST OF TABLES	x
LIST OF FIGURES	xii
ABSTRACT	xiii
PREFACE	xv
<u>1. INTRODUCTION</u>	1
1.1. TRADITIONAL APPROACHES TO CLASSIFICATION	6
1.1.1. Heinz Werner	6
1.1.2. Vygotsky's Account of Concept Formation	7
1.1.3. Genevan School	10
1.1.4. Points in Common in Classical Approaches	15
1.2. RECENT STUDIES OF GROUPING BEHAVIOUR IN THE FIRST THREE YEARS	17
1.2.1. Equivalence Classifications	17
1.2.2. Manual Groupings of Objects	18
1.2.3. <u>Implications of New Studies for Traditional Accounts of Classification with Particular Reference to Piaget</u>	21

	<u>Page</u>
1.2.4. Sugarman's Procedural Approach	23
1.2.5. Implications of Sugarman's Approach for Piaget's Account of Classificatory Development	26
1.2.6. Other Evidence for Co-ordination of Interobject Comparisons	27
1.2.6.1. Class inclusion studies	27
1.2.6.2. Bidimensional classification	29
1.2.7. The Cultural Context of Studies of Early Grouping Behaviour	31
1.3. ENVIRONMENTAL EFFECTS ON GROUPING BEHAVIOUR	32
1.3.1. Effect of Specific Task Characteristics on Determining Performance on Grouping Tasks	34
1.3.1.1. Stimulus prototypes and natural categories	36
1.3.2. Sociocultural Effects on Performance on Grouping Tasks	38
1.3.2.1. Cross-cultural studies of classification and concept development in the preschool child	39
1.3.2.2. Cross-cultural studies of classification and concept development in the concrete operational child	41
1.3.3. Factors Affecting Competence on Cognitive Tasks	43
1.4. THE PRESENT STUDY	46
<u>2. METHOD</u>	50
2.1. DESIGN	51
2.1.1. Criteria Governing the Choice of Subjects	51
2.1.2. Criteria Governing the Choice and Presentation of Materials	56

	<u>Page</u>
2.1.2.1. Materials	57
2.1.2.2. Order of presentation	59
2.1.3. Choice of Experimenter	59
2.1.4. Test-retest Reliability	60
2.1.5. Measures of Grouping Behaviour	60
2.2. PROCEDURE	62
2.2.1. Experimental Situation	62
2.2.2. Spontaneous Play	64
2.2.3. Elicitation Tasks	65
2.2.3.1. Elicited grouping task	65
2.2.3.2. Misplacement task	66
2.3. ANALYSIS	66
2.3.1. Coding and Scoring	66
2.3.2. Choice of Statistical Tests	69
<u>3. RESULTS</u>	71
3.1. PART ONE: AGE EFFECTS ON GROUPING BEHAVIOUR	74
3.1.1. Sequential Ordering	74
Summary Sequential Ordering	76
3.1.2. Spatial Constructions - Unidimensional Grouping Criteria	77
3.1.2.1. Preliminary analyses	77
3.1.2.1.1. Base rate	77
3.1.2.1.2. Sex-related effects	78
3.1.2.1.3. Construction size	78
3.1.2.1.4. Class-consistent constructions	80

	<u>Page</u>
(a) Types of consistent construction	80
(b) Overall consistency	82
(c) Size/consistency relations	83
(d) Consistent organisation of two classes	84
Summary Preliminary Analyses	85
3.1.2.2. Classes	85
3.1.2.2.1. Products	85
(a) Frequency of class grouping	87
(b) Most exhaustive class grouping	88
3.1.2.2.2. Class grouping procedure	90
(a) Spontaneous condition	90
(i) Baseline data	91
(ii) Handling two classes in mixed or unmixed order	92
(b) Elicited condition	93
(i) Elicited grouping task	93
(ii) Misplacement task	96
(c) Comparison of elicitation tasks and spontaneous performance	98
Summary Classes	100
3.1.2.3. Between-class correspondence	100
3.1.2.3.1. Products	100
(a) Precise and imprecise correspondences	101
(b) Number of subunits	102

	<u>Page</u>
3.1.2.3.2. Correspondence grouping procedure	104
Summary Between-class Correspondence	106
3.1.2.4. Between-class symmetry	107
3.1.2.4.1. Products	107
3.1.2.4.2. Symmetrical grouping procedure	108
Summary Between-class Symmetry	111
3.1.2.5. Comparison of the three types of consistent construction	111
3.1.2.5.1. Products: Inclusiveness of constructions	111
3.1.2.5.2. Grouping Procedure	113
Summary Comparison of Types of Consistent Construction	114
3.1.3. Spatial Constructions - Bidimensional	114
3.1.3.1. Products	115
3.1.3.1.1. Number of bidimensionally consistent subclasses	115
3.1.3.1.2. Most consistent construction with four subclasses	117
3.1.3.2. Grouping procedure	119
3.1.3.3. Comparison of bidimensional and unidimensional constructions	120
Summary Bidimensional Constructions	122
3.1.4. Verbal Expressions of Class Relations	122
Summary Verbal Expressions of Class Relations	126
3.2. PART TWO: EFFECTS OF TASK CHARACTERISTICS ON OBJECT GROUPING BEHAVIOUR	127
3.2.1. Preliminary Analyses	127
3.2.1.1. Time used on each task	128

	<u>Page</u>
3.2.1.2. Saliency	129
3.2.2. Task Effects on Sequential Ordering of Classes	130
3.2.3. Task Effects on Spatial Constructions	131
3.2.3.1. Products	131
3.2.3.1.1. Base rate	131
3.2.3.1.2. Task and type of grouping	131
3.2.3.1.3. Task effects on consistency of constructions	133
3.2.3.1.4. Task effects on constructions at different ages	137
3.2.3.2. Grouping procedure	139
Summary Task Effects on Object Grouping Behaviour	139
<u>4. DISCUSSION</u>	141
4.1. OVERALL TRENDS IN GROUPING BEHAVIOUR: A COMPARISON OF YOUNG CHILDREN FROM LOW AND MIDDLE LEVEL SOCIO-ECONOMIC BACKGROUNDS	143
4.1.1. Grouping According to Unidimensional Criteria - Temporal and Spatial Constructions	143
4.1.2. Evidence for Co-ordinated Grouping Procedure	144
4.1.3. Grouping According to Bidimensional Criteria	148
4.1.4. Verbal Expressions of Class Relations	150
4.2. TASK EFFECTS ON THE GROUPING BEHAVIOUR OF YOUNG CHILDREN FROM A LOW SOCIO-ECONOMIC BACKGROUND	151
4.3. METHODOLOGICAL CONSIDERATIONS	153
4.3.1. Design	153
4.3.2. Coding	153

	<u>Page</u>
4.3.3. Experimental Procedure	154
4.4. QUESTIONS FOR FUTURE RESEARCH	154
<u>5. REFERENCES</u>	158
<u>APPENDICES</u>	172
APPENDIX A: THE ATHLONE ELC SOCIO-ECONOMIC INDEX	173
APPENDIX B: PRESENTATION ORDERS FOR THE SIX TASKS	175
APPENDIX C: EXAMPLE OF TRANSCRIBED AND CODED DATA	176
APPENDIX D: STATISTICAL VALUES FOR ALL COMPUTATIONS FOR PART TWO: TASK EFFECTS ON GROUPING BEHAVIOUR	184

LIST OF TABLES

	<u>Page</u>
1 Description of the Four Groups of Subjects	55
2 Number of Subjects in Each Response Category for Sequential Ordering	75
3 Number of Constructions in Different Size Ranges for Each Age Group	79
4 Types of Construction by Age	82
5 Number of Consistent Constructions by Size and Age	83
6 Number of Subjects in Each Response Category for Most Exhaustive Grouping	89
7 Number of Subjects in Each Response Category for Spontaneous Grouping Procedure	92
8 Number of Subjects in Each Response Category for Elicited Grouping Task	94
9 Number of Subjects in Each Response Category for Misplacement Task	97
10 Class Grouping Measures on which Subjects Achieved Co-ordination of Classes	99
11 Relative Frequencies of Precise and Imprecise Correspondences per Age Group	101
12 Number of Subjects at Each Age Level Utilising Different Numbers of Subunits in their Correspondence Constructions	102
13 Number of Subjects in Each Response Category for Correspondence Grouping Procedure	105
14 Subjects' Most Co-ordinated Spontaneous Class Grouping Procedure by their Most Co-ordinated Correspondence Procedure	113
15 Number of Subjects in Each Age Group Using Different Numbers of Bidimensionally Consistent Subclasses	116
16 Number of Subjects at Different Ages in Each Response Category for Constructions with Four Subclasses	118

	<u>Page</u>	
17	Number of Subjects in Different Response Categories for Verbal Reference to Class Relations	123
18	Mean Number of Seconds per Task for the Different Age Groups	128
19	Number of Subjects Manipulating One Subset for More than 67% of their Moves on a Task	129
20	Number of Responses in Each Category of Construction for the Five Tasks	132

LIST OF FIGURES

	<u>Page</u>
1 Schematic Drawings of Test Objects	58
2 Each Subject's Age in Months by Highest Number of Subunits Constructed	103
3 Each Subject's Age in Months by Highest Level of Correspondence Grouping Procedure	105
4 Between-class Symmetries Produced by Subjects	109
5 Mean Percentage of Consistent One- and Two-Class, and Mixed Constructions for Each Task	133
6 Percentage of Consistent Constructions by Age Groups A, B, C and D for Each Task	137

ABSTRACT

Recent studies of object grouping in infants and preschool children by Sugarman (1983) suggest that they are capable of conceptualising inter-relationships between objects - a view which differs from accounts of classification by Inhelder and Piaget (1964) and Vygotsky (1962). These studies have concentrated on Western middle-class subjects. This study investigated the development of conceptual organisation seen in the grouping of sets of objects by young children, classified as "Coloured", from a low socio-economic background. A second focus of the study was on the effect of specific task variables on object grouping behaviour. Thirty-one low income subjects divided into four age groups - 16-24, 25-30, 31-36 and 37-42 months, were given six different free sorting tasks. Each involved the presentation of a scrambled array of eight objects to be divided into two classes. In one task the objects could be classified by bidimensional criteria, in the others by a single criterion. Subjects' spontaneous manipulations of the objects were measured in three ways - temporal grouping, spatial grouping and grouping procedure. Verbal references to class relations were also coded. For measures of temporal and spatial grouping, frequency of consistent one- and two-class groupings and inclusiveness of constructions were noted. Grouping procedure provided

a measure of whether or not both classes were simultaneously considered. An additional two tasks designed to elicit simultaneous consideration of both classes were also administered to each subject. The data was analysed for differential age and task effects on grouping. The results indicate that performance on these tasks showed the same general developmental trends and task effects as those found in recent studies of middle-class children for both unidimensional and bidimensional groupings, thus confirming Sugarman's observations and suggesting a universal process of conceptual development. However, there was some evidence of a slower rate of development and levels of verbalisation were lower than those observed in studies of middle-class children. Subjects in this study could conceptually inter-relate objects shown both in their bidimensional groupings and in mixed order grouping procedure, but the latter was evident in elicited groupings and not in spontaneous play. These differences are discussed in relation to performance variables such as response set.

PREFACE

The search for an understanding of the origins and development of logical processes in infancy and early childhood has long been of interest to psychologists and educationalists alike. One of the central points of this development is the child's growing ability to comprehend the properties which govern the formation of class systems or categories which will form the basis of adult thought patterns. Developments in classification in the infant and young child have usually been inferred from the way that they group similar sets of objects. Recent studies (e.g. Odom, Astor and Cunningham, 1974; Sugarman, 1983) have suggested that traditional accounts of this development by Inhelder and Piaget (1964) and Vygotsky (1962) have under-estimated the level of conceptualisation within the capacity of the pre-operational child and have shown that children in the third and fourth year of life are able to perform simple tasks requiring them to co-ordinate relations between objects.

However, the majority of these studies performed on middle-class Euro-American children appear to tacitly assume that the trends they have noted in the development of classification skills are cognitive universals. Consequently there has been little attention to the influence of environmental factors on the development of such skills, despite indications that performance on cognitive tasks differs widely in different cultures and

social classes. The purpose of this study was therefore to describe the development of object grouping skills in a sample of lower-class children. It is purely a study of this behaviour in a different social class, and does not reflect the view that there is a distinct "culture of poverty", nor is the political designation of the subjects of the study as "Coloured" seen to reflect a distinct cultural group. In addition to the description of age-related changes in grouping behaviour, specific effects of different materials on this behaviour will be examined. The subjects of the study range from 16 to 42 months, an age range which is of interest for two reasons: firstly, it is the range in which studies suggest children become capable of co-ordinating concepts and relationships between them, and secondly, it is the age range in which social class differences on many cognitive tasks become apparent.

The types of object grouping produced by the lower-class subjects of this study will then be discussed in relation to previous findings with middle-class subjects, and the implications they have for the view that young children exceed the level of competence seen in Vygotsky's and Inhelder and Piaget's studies of classification. The effects of different materials on object grouping will also be considered. It is, however, only a starting point to pinpoint differences in performance which seem to be related to social class and specific materials.

Understanding of such differences will require further research and this study suggests some possibilities which might be investigated.

## 1. INTRODUCTION

- 1.1. TRADITIONAL APPROACHES TO CLASSIFICATION
  - 1.1.1. Heinz Werner
  - 1.1.2. Vygotsky's Account of Concept Formation
  - 1.1.3. Genevan School
  - 1.1.4. Points in Common in Classical Approaches
  
- 1.2. RECENT STUDIES OF GROUPING BEHAVIOUR IN THE FIRST THREE YEARS
  - 1.2.1. Equivalence Classifications
  - 1.2.2. Manual Groupings of Objects
  - 1.2.3. Implications of New Studies for Traditional Accounts of Classification with Particular Reference to Piaget
  - 1.2.4. Sugarman's Procedural Approach
  - 1.2.5. Implications of Sugarman's Approach for Piaget's Account of Classificatory Development
  - 1.2.6. Other Evidence for Co-ordination of Interobject Comparisons
    - 1.2.6.1. Class inclusion studies
    - 1.2.6.2. Bidimensional classification
  - 1.2.7. The Cultural Context of Studies of Early Grouping Behaviour

1.3./...

1.3. ENVIRONMENTAL EFFECTS ON GROUPING BEHAVIOUR

1.3.1. Effect of Specific Task Characteristics on Determining Performance on Grouping Tasks

1.3.1.1. Stimulus prototypes and natural categories

1.3.2. Sociocultural Effects on Performance on Grouping Tasks

1.3.2.1. Cross-cultural studies of classification and concept development in the preschool child

1.3.2.2. Cross-cultural studies of classification and concept development in the concrete operational child

1.3.3. Factors Affecting Competence on Cognitive Tasks

1.4. THE PRESENT STUDY

## 1. INTRODUCTION

In this section the purpose of studying grouping behaviour is outlined and traditional approaches to the study of classification are considered. Recent studies of grouping behaviour in the first three years of life are reviewed and their implications for more traditional approaches are discussed.

A major preoccupation for cognitive psychologists is the investigation of the origins and structure of logic in infancy, its progress in early childhood, and the processes by which it develops. Of particular interest to psychologists and educationalists alike is the study of class or concept, the "notion of sameness" which becomes "the very keel and backbone of our thinking" (James, 1901, p. 459). Flavell (1970) comments: "The entities called 'classes' have a dual status in human cognition. On the one hand, they are usually regarded as essential ingredients of the thinking process itself ... On the other hand classes can also constitute abstract 'objects of thought'" (p. 991). It is particularly in this second sense of general logical systems rather than as isolated conceptual units that the study of classificatory knowledge can further our understanding of the development of cognition. The individual's growing understanding of the properties of

class systems provides the basis for the later formation and use of superordinate categories found in mature Western patterns of thinking. As such, classification touches every area of conceptual development.

For the title of this study, the term "grouping" was preferred to the more frequently used "classification". This was done for two related reasons. Firstly, it is from such behaviour expressed either as an equivalence response to similar but discrete stimuli (Bornstein, 1981; Kendler, 1961) or in the way that children organise groups of objects (e.g. Inhelder and Piaget, 1964; Nelson, 1973; Ricciuti, 1965) that underlying conceptual organisation can be inferred. It is conceivable, indeed likely, that certain groupings produced will not reflect classification at all. Secondly, the term "classification" is usually understood following Inhelder and Piaget as grouping on the basis of a common attribute and strictly speaking excludes related object groupings common in the age range under study (cf. Flavell, 1970, p. 995). These include patterns, symmetries, and correspondence between items from different classes. All these can be seen to reflect logical organisation (Forman, 1982; Ricciuti & Johnson, 1965, cited by Flavell, 1970; Sugarman, 1983) and as it is the concern of this study to consider groupings by a consistent relation as broadly as possible, all these forms are taken into account.

In studying the development of classification as a logical system it is useful to consider the different sources of variation in the subject-concept relation.

Flavell (1970) identifies three of these:

- (1) validity, which is a measure of the extent to which the individual's concept meets the publicly accepted meaning;
- (2) status, which refers to the extent to which the concept is articulated, coded and understood - a cognitive object as opposed to a cognitive instrument; and
- (3) accessibility, which is the degree to which a concept is available for use in appropriate situations.

There are a number of accounts of how these change as the child develops and the sequence will be re-examined here from the point of view of two important movements in cognitive developmental psychology. Firstly, in the last ten years or so, infants have come to be viewed as more competent than earlier accounts would have them (Bower, 1974; 1979; Vuyk, 1981). Piaget's (1972) view that logic related to action in the sensorimotor period differs structurally from the logic according to reason that succeeds it, has been challenged. Mounoud and Hauert (1982), Mounoud and Vintner (1981) postulate a distinction

between reasoning logic and action in infancy. Langer (1980, 1981, 1982) too describes forms of logical behaviour and representation in infancy which appear to go beyond Piaget's logic-in-action (1963). Whether or not studies of early grouping suggest that logical forms develop earlier than traditional accounts allow will be considered. Secondly, evidence from a variety of studies, in particular cross-cultural studies and studies of horizontal decalage within a single culture points to "the major effects of specific task characteristics in determining performance on cognitive tasks" (Furby, 1980, p. 546). It therefore becomes important to consider the validity, status and accessibility of the child's concepts within his particular realm of experience.

### 1.1. TRADITIONAL APPROACHES TO CLASSIFICATION

The development of classificatory knowledge has been approached from a number of perspectives and it is within the classical studies of Werner (1940), Vygotsky (1962) and Inhelder and Piaget (1964) that a framework for considering more recent work focussing on the young child will be found.

#### 1.1.1. Heinz Werner

Werner (1940), drawing on a variety of studies as sources, contrasted sensory organisation and primitive

abstraction with abstract conceptual classification. He observed that grouping on the basis of perceptual configuration is reflected in the categories of primitive languages and that young children similarly often conceive of a group as a "naturalistic situation in which single elements are embedded and from which they get their meaning" (p. 227). Another grouping criterion for young children was concrete similarities. On the basis of these observations Werner concluded that primitive abstraction is closely allied to sensory organisation.

The groupings change with age to include grouping according to two dimensions and then the forming of subgroups until the child (post six years) can shift his viewpoint so he is free of the forces of sensory stimulation and consciously perceives that objects can be ordered on the basis of any one of their different attributes. This mature level of abstraction is one "guided by deliberately selected categories" (p. 239).

#### 1.1.2. Vygotsky's Account of Concept Formation

Vygotsky (1962) observed similar types of grouping in young children, but places major emphasis on the guiding role of the symbol (word) in concept formation. It is beyond the bounds of this study to consider the role of language in forming categories, but the Russian work is relevant here as it identifies a number of stages in the growth of classification. Vygotsky sees concept

formation as the result of an intellectual operation which has two main parts: firstly, a complex is formed - children unite diverse objects in groups under a common family name. Secondly, potential concepts are formed based on singling out common attributes. Words centre attention in both these lines of development by abstracting traits, synthesising them and symbolising them with a sign.

The method by which grouping is studied has more than an incidental effect on the child's performance (Denney, 1972; Furby, 1980; Siegel, 1978) and for this reason the materials used in Vygotsky's study will be described in detail. He used 22 wooden blocks varying in colour, height (tall and flat), shape and size of the horizontal surface. Under each figure, unseen by the subject, was written one of the four nonsense words, lag, bik, mur or cev. Lag was written on all tall figures regardless of colour or shape, bik on flat ones, mur on tall small ones and cev on flat small ones. At the beginning of a testing session all blocks were presented in mixed array. The experimenter turned up a block, told its name to the subject and asked him to find all the blocks he thought belonged to the same kind. Once the subject had made his choice, the experimenter turned up one of the wrongly selected blocks, showing him that it was a different kind and the subject tried again. As the number of turned blocks increases, the subject obtains a basis for discovering

the attributes to which the nonsense word refers.

The words then come to stand for the different types of blocks. From the types of groupings produced and errors made, three basic phases of concept formation were inferred.

Firstly, the young child puts a number of objects in an unorganised syncretic heap, i.e. diverse elements are merged into a group on the strength of some chance impression which might be based on organisation of the visual field (contiguity in space) or comprise elements from heaps already formed.

In the second complex phase of grouping, individual objects are united in the child's mind on the basis of bonds which actually exist between them. (Here Vygotsky, like Werner (1940), uses the analogy of family name.) This might be an "associative complex" where any feature in which the sample object is like others suffices as a basis, e.g. some are like in colour, others in size. Collective complexes are those in which objects are grouped on the basis of functional co-operation, e.g. placed together on the basis of a trait in which they differ and consequently complement each other, e.g. a block of each colour; a placesetting. Chain complexes are a result of the relation between single elements, e.g. a child groups a yellow triangle, adds a few more on the basis of triangularity and then changes to the colour of the last triangle he added. Here the original sample has no central significance. Diffuse complexes

are not even based on perceptual similarity and are characterised by the fluidity of their attributes.

The last form of complex identified by Vygotsky was the pseudo concept. Here it appears that there was a conceptual basis for grouping but it was based on concrete visible likeness rather than true general concept.

In the next phase of the development of abstraction objects are grouped on the basis of a single attribute. The potential concept, a precursor of the true concept, results from a primitive abstraction present to some degree not only in children but even in animals. The genuine concept is formed "only when the abstracted traits are synthesised anew and the resulting abstract synthesis becomes the main instrument of thought" (p. 78). So, while similar forms are found at earlier stages, Vygotsky concludes "The development of the processes which eventually result in concept formation begins in earliest childhood, but the intellectual functions that in a specific combination form the psychological basis of the process of concept formation ripen, take shape and develop only at puberty" (p. 58).

### 1.1.3. Genevan School

The Genevan school has contributed the fullest account of the development of classificatory knowledge as a logical system, and it is on this basis that the bulk of developmental studies in this area have been

conceptualised.

Inhelder and Piaget (1964) have stringent criteria for the logical definition of a class. There are two ways the class is defined: by intension which specifies the properties shared by the members of the class and by extension which lists the members. Extension requires an understanding of differential magnitude relations implied in superordinate/subordinate class systems (Hooper, 1979) and is often tested empirically by questions involving the quantifiers some, all and none.

At the sensorimotor stage Piaget (1952) describes a number of behaviour patterns suggestive of a practical classification as when a child given a familiar object assimilates it to an habitual scheme. A second preverbal precursor is when children pile a number of similar objects together. But he considers these prototypes to be " ... elementary organisations ... still far removed from the corresponding operational structures" because a "characteristic of a sensorimotor scheme is that its various possible applications cannot be realised simultaneously so that extension and intension cannot be co-ordinated by reference to one another." Inhelder and Piaget (1964, p.14 ).

On the basis of studies with nearly 200 children aged two-and-a-half to seven years, Inhelder and Piaget identified three stages of development, two pre-operational and one at the stage of concrete operations. The method

followed in the studies was to present subjects with a variety of materials, either geometric - blocks of differing shape and colour - or descriptive, e.g. figures of people, houses, animals, trees, cars, and to instruct them to "Put together things that are alike."

From two to four years children produced preclasses determined at times by similarity or at others by the making of a picture. These were termed graphic collections and included:

- (1) placing objects in line;
- (2) collective objects which were graphic collections in two or three dimensions made up of similar elements, together constituting an unbroken whole, pattern or geometric figure;  
and
- (3) complex objects made of heterogeneous elements, the end product being either a geometric figure or descriptive or pictorial.

These types did not appear in a particular sequence and were a function of the task materials and the way questions were put. What is common to them is the way that relations of similarity and difference were applied successively. The child oscillates between extension and intension, unable to unite all elements

with the common property to form a simultaneous whole. Extension is simply a spatial or graphic extension of a perceptual whole.

Later Piaget (1977) distinguished a transitional level between these graphic collections and the next non-graphic stage. This includes figural collections with superimposed alignments each having analogous elements distinct from those of other subcollections, and small non-figural but juxtaposed collections without a unique criterion. Between four and seven years the child was observed to become capable of a quasi classification - the non-graphic collection. These are distinguished from the previous stage in that they are consistent and exhaustive. Typically all the elements were grouped into two or more collections on the basis of similarity. In its most advanced form the non-graphic collection may distinguish classes and subclasses, though the child still cannot co-ordinate two dimensions. Nor are these true classes as they are constructed step by step without an explicit understanding of the definition of the class.

The final stage of classificatory thinking is achieved when the child understands the relations among the different levels of the hierarchy. He needs to understand class inclusion - the way that members of the subclass are members of a class but that the reverse is not necessarily true. In Piaget's Western European

subjects this level was reached at about 10 years.

The role of an anticipatory scheme is emphasised as the key to this developmental progression. The child at Stage I (graphic collection) "does not really anticipate the classification ... (but) establishes it in the course of constructing the collection which he does one step at a time" (p. 196). Once having made the collection the child is inflexible and cannot change it or offer an alternative. By Stage III the child does not proceed at all until he has an anticipatory schema.

Inhelder and Piaget (1964) also give attention to the logically more complex multiplicative classification which requires the consideration of two or more dimensions and their arrangement in the form of matrices. To establish these tables the child must compose two or more criteria and a spatially correct placement must be made. As these arrangements are supported by graphic representation, the question is whether perceptual factors compensate for the additional logical complexity or are merely an initial aid to solving a problem that soon becomes purely symbolic. They interpret the finding that younger children aged four to five are more successful at solving these tasks than six- to seven-year olds as indicating that younger children are solving the matrix on the basis of perceptual symmetry whereas the older children are attempting to co-ordinate the different dimensions. Despite this unevenness in the composition of multiplicative rather than additive classes they were

seen to develop parallel to and at the same time as additive classification.

#### 1.1.4. Points in Common in Classical Approaches

A great deal of common ground can be found in these three approaches. Firstly, discrimination on the basis of likeness or difference is not considered sufficient proof of classification. Classification seems to be marked by the ability to hold consistently to a criterion of grouping, to proceed by a plan, and to be able to abandon this criterion deliberately and reclassify on a new basis. This has much in common with Bruner's "formal" category (Bruner, Goodnow and Austin, 1956). Secondly, these accounts concur that young children under around four years are unable to form groups of objects based on a single common attribute because of their lack of concept of group or category which could be defined by a specific set of objectively determined features. The perceptual nature of groupings is stressed. (Here the effect of the large numbers of test objects with overlapping attributes will need to be considered.) Finally, there is a large measure of agreement in the kinds of grouping produced in the intuitive phase of pre-operational development. It is useful to employ Olver and Hornsby's (1966) categorisation of thematic and complexive groupings. These were observed in studies with older children from six years, using more complex materials. Thematic groupings which join elements by

some kind of story or theme were observed by Inhelder and Piaget and Werner in this age range. Complexive groupings of which there are many subvarieties "appear to be the result of a conventional find the common attribute strategy which the child fails ... to carry off for the whole set of objects to be grouped" (Flavell, 1970, p. 994). The result is what Kofsky (1963) has termed an inconsistent class. Closely related to this is non-exhaustiveness - not all elements possessing the property on which class membership is based are included. Inconsistent groupings have been noted by both Vygotsky (1962) and Inhelder and Piaget (1964), as well as Bruner, Olver and Greenfield (1963, Chapter III) and Lovell, Mitchell and Everett (1962).

The sequence of these approaches unfolds logically from simpler to more complex organisational levels which will enable the maturing child to encode information in simpler chunks and combine and detach groupings already formed with greater efficiency. As such they provide a useful framework to consider subsequent studies. What is of interest here is to examine more closely how this developmental sequence manifests at different ages and under different conditions.

## 1.2. RECENT STUDIES OF GROUPING BEHAVIOUR IN THE FIRST THREE YEARS

### 1.2.1. Equivalence Classifications

At its simplest level classification is said to exist when two or more discrete events elicit equivalent behavioural responses. This is a basic adaptive mechanism found even in the simplest organisms which need to recognise similar sensory inputs in order to survive (James, 1901). As such it is found even in the first weeks of life of the infant (Bornstein, 1979; 1981). More compelling evidence that infants actually group discriminable stimuli within certain domains into equivalence classes comes from studies in which infants' receptive behaviour shows generalisation in the same category (Cohen and Strauss, 1979; Fagan, 1974, 1979). Bornstein (1981) demonstrated habituation to colours (even novel colours) and dishabituation to a neutral pattern - indicating a response to colour as a general dimension or concept rather than a particular colour. Further, Bornstein has demonstrated that infants can learn to respond differentially in one situation to stimuli that they treat equivalently in another.

These studies essentially describe the sensorimotor scheme (Piaget, 1963), the motoric prototype of classification discussed above. Clearly equivalence classifications are precursors of intension but there is no proof that infants responding equivalently have a concept of equivalence. However, this paradigm has been

used as evidence of categorisation by older children, e.g. Rossi and Rossi (1965) have demonstrated a significant degree of grouping of like items in recall by two-year olds.

### 1.2.2. Manual Groupings of Objects

The overt behaviour of manually grouping similar objects has also been seen as the beginning of classification, and there is little evidence of this in the first year. Inhelder and Piaget (1964) do not specify when pregraphic groupings of like objects begin to be seen. Langer (1980, 1982) has shown a shift in the constructive behaviours of infants from composing (spatial contact of proximity in placements and displacements) two different objects at six months to random compositions of two or sometimes three objects at 8 to 10 months, to some infants beginning to compose two or even three identical objects at a year. Fenson, Kagan, Kearsley and Zelazo (1976) also found very simple groupings on the basis of physical and functional similarity, a few at 9 months and frequently by 13 months. Starkey (1981) found spatial groupings of two and three like objects in some nine-month olds. Starkey found that his six-month old subjects could distinguish between types of objects but showed no sequential touching of like objects or spatial groupings, indicating that this behaviour emerges between six and nine months.

The method of assessing grouping used by Starkey (1981) and a variety of the studies reported below is based on

Ricciuti (1965). He had failed to elicit grouping with very young children on sorting tasks introduced with verbal instructions but noted that such groupings were common in their spontaneous play. He introduced a simplified task with eight objects classifiable into two mutually exclusive subsets on the basis of a single criterion. Spontaneous manipulations of these objects by 12-, 18- and 24-month infants showed a high degree of ordering. Temporal orderings were seen even where no spatial groupings were produced

Riccuiti (1965) observed the grouping behaviour of 48 children and found that roughly 40% of 12-month olds, 80% at 18 months and 70% of 24-month olds touched like objects sequentially. Thirty, 50 and 67% at 12, 18 and 24 months also grouped like objects spatially. This suggests that spatial groupings require other skills than just classification and that the failure of younger children to produce spatially contiguous groups should not be seen as a failure to group. Starkey likewise found sequential touching of three or more objects in 94% of 9-month olds and all his 12-month subjects. Spatial groupings were produced by 13% at 9 months and 44% at 12. Sugarman (1981, 1982a and b) also reports temporal and spatial groupings from 12 months. The groupings seen in Ricciuti and Starkey were perceptually based. Functional categorisation has been shown by both Ross (1980) from 12 months, and Nelson (1973) from 18 months. Nelson (1973) hypothesised that

the function of objects is the most primitive dimension along which the child will group objects and that using realistic objects could tap already formed categories. Her findings confirm that the function of objects is a salient principle of categorisation under two years. Ross (1980) used the habituation-dishabituation paradigm, so much used in the study of equivalence responses in early infancy. The method was based on the premise that as a category is a group of physically distinct objects to which equivalent meaning is given, children would habituate to successive members of the same category and show recovery of attention to a member of a different category. She found that children at 12, 18 and 24 months recognised some conventional categories including superordinate categories such as food and furniture in which members had varied perceptual characteristics.

The groupings which appear in the first and much of the second year are not conclusive evidence of a search for similar objects which would indicate some concept of equivalence. Children may be selecting objects that are most salient to them in which case there would be no need to compare objects. Evidence for this view, especially at around one year, comes from the predominance of one class groupings (Ricciuti, 1965; Starkey, 1981; Sugarman, 1981, 1982a and b). Ricciuti notes that there was a tendency across his sample to select an object from the same class on the first move of a task. This finding is consistent with the expectation that younger children

can only attend to one thing at a time (the "centred" thought referred to by Piaget, 1978), i.e. they separate x from not x but cannot separate x from y which requires attending to the class basis of both categories.

By 24 months the number of objects grouped and the frequency of two or more class groupings increases and the possibility of salience as an explanatory feature decreases (Denney, 1972; Nelson, 1973; Ricciuti, 1965; Sugarman, 1982a and b), though it is possible that two class groupings could be produced on the basis of repeated searches for an object like the one previously placed, as Piaget's successive assimilation account suggests (also Sigel, 1964). It is, however, more likely that there is some interobject comparison (Sugarman, 1983). At this stage too there is an increase in spatial co-ordination between small groupings (Inhelder and Piaget, 1964; Ricciuti and Johnson, 1965, cited by Flavell, 1970; Kofsky, 1966; Sugarman, 1983, Vygotsky, 1962; Woodward and Hunt, 1972). As has been noted, this is often at the expense of maintaining class consistency when non-identical objects are sorted together. However, Sugarman's subjects have produced symmetrical forms which appear to co-ordinate position in space and form; a trend also noted by Ricciuti and Johnson.

### 1.2.3. Implications of New Studies for Traditional Accounts of Classification with Particular Reference to Piaget

The studies reviewed to this point show a steadily increasing ability to group consistently and exhaustively

more evident on the simplified tasks without overlapping attributes, but leave unchallenged Piaget's account of the limitations of classification in the preschool period to successive two term comparisons and a heavy reliance on perceptual cues. Even the two class groupings common over 24 months could be accounted for in these terms, particularly when there is only one dimension for classification.

While these grouping studies give no evidence of changes in cognitive organisation during the third year, evidence from studies of the language ability of children in this age group indicates a period of dramatic change. For example, children progress from the simple meanings of early language which appear to link with sensorimotor concepts (Brown, 1973) to using a grammar (Karmiloff-Smith, 1979; Newport, 1981) and the recognition of commonalities among words which share semantic features (Bowerman, 1978). There is a great deal of evidence suggesting support for Piaget's position that language "largely follows on the heels of general cognitive development" (McCall, Eichorn and Hogarty, 1977), that uncoded knowledge about how objects can be related to each other needs to be mapped into linguistic systems (Flavell, 1977, p. 38). Goodson and Greenfield (1975) and Greenfield, Nelson and Saltzman (1972) have demonstrated parallels in linguistic structural principle and structure in manipulative play, lending support to the idea of common cognitive organisation in language and other behaviour. Studies of grouping behaviour also lend support to this (Nelson, 1973,

Ricciuti, 1965). Sugarman (1982) therefore queries whether just as language development in this period moves from direct expressions of meaning to increasingly indirect forms and the use of more complex internal structures of external forms, mappings from thought (internal structure) to sequence of action (external form) do not also become increasingly elaborate.

#### 1.2.4. Sugarman's Procedural Approach

Sugarman (1983) argues that the construction of two class groups could be interpreted as a more complex mental process. The child needing to consider two classes simultaneously must know that two objects are the same in some respect and also that there are two possible bases on which the objects may be categorised. The child with such knowledge might have "stepped up from a comparison of particulars to a simultaneous juxtaposition, if not a comparison, of comparisons" (p. 10).

What was necessary was a method of analysing classificatory behaviour that could distinguish the behaviour and its conceptual underpinnings. Sugarman (1982b) argued that "the same spatial arrangement or temporal sequence of object manipulation by different children might reflect a different conceptual organisation of objects and conversely that superficially dissimilar forms might reflect the same or similar conceptual organisation" (p. 68).

She therefore chose to work from units of class-consistent organisation to the way in which each unit was produced and then inferred from the activity patterns what the

minimal underlying conceptual organisation was to generate that pattern, e.g. if younger children grouped two classes one at a time and older children could shift between classes when grouping, the younger pattern indicates an understanding of  $x = a$  but the shifting pattern indicates a co-ordination of the concept  $x = a$  and  $x = b$ .

Sugarman (1982a) presented 40 children, eight each at 12, 18, 24, 30 and 36 months, with seven sets of materials. These varied so that some would facilitate class groupings and others, by permitting containment, one-to-one correspondence. Each set included two classes of four items each. After two-and-a-half minutes' spontaneous play, two probes were given, designed to elicit specific class grouping and involving the joint consideration of classes. The first was to prompt subjects to sort objects into separate class groupings while shifting from one class to another. The second looked at the subject's free response to a partially grouped array with one object from each class misplaced with the other class. This tested whether the child could reverse the misplaced objects without resorting all the objects.

She found (1982a) in the spontaneous play condition that children at all ages grouped identical objects with roughly the same frequency, but that composition of the groups and the way they were formed changed with age. At 12 and 18 months, most infants grouped mainly from one class or

successively grouped two. From 24 months onwards, class groupings tended to include objects from two classes and subjects began shifting between classes during their production. A different cognitive strategy is clear, grouping one class at a time requires keeping only one kind of object in mind at a time; shifting between classes while grouping requires that the child considers both groups, and in selecting an object has to decide to which the object belongs. The elicited groupings revealed the same trends. When placed before one item of each class a small distance apart and presented with the remainder in scrambled order, some, particularly younger children, persevered in one class groupings. Fifty-eight percent of the 24-month and older children grouped in mixed class order as given. Likewise, in correcting the misplaced objects, while some children at all ages were successful, more than half of the 30 - 36-month children simply reversed them. Most of the children under 24 months, if they corrected at all, did so by moving all or most of the objects into a new configuration one class at a time (again considering only one type of thing at a time).

Sugarman (1982b) tested the generality of these trends by also looking at the development of the one-to-one correspondence between classes. Superficially this appears to be a different skill, but like class grouping, it depends on an ordering that maintains a constant relation across the series. Trends in developmental sequence of

between class correspondence also suggested a progressive disjunction of action and thought.

On the basis of these studies, Sugarman (1982a and b, 1983) identifies four phases in the way children analyse inter-object relations:

1. Around 12 months conceptual structuring is focused around individual objects. Class ordering seems to depend on salience.
2. In the 18 - 24-month period, individual objects are conceptually interrelated by comparison. Items are equated because they look the same or serve the same function. This involves the construction that 'a' and 'b' are distinct but have something in common.
3. At 24 months the process of interrelating individual objects becomes recursive, that is, the child repeats the pattern until no further items or combinations can be found.
4. From 30 months on, children can organise objects according to two schemes at once. Examples of this co-ordination of relations between objects include grouping two classes in mixed order and the appearance in the third year of bidimensional classification.

#### 1.2.5. Implications of Sugarman's Approach for Piaget's Account of Classificatory Development

On the basis of this summary of her findings, Sugarman (1983) rejects Piaget's view (1951) of the period between the emergence of representation and the preconceptual period

as largely an extension of sensorimotor intelligence, one in which there is little structural change and thought oscillates between purely motor and figural characteristics. She suggests rather that it seems to undergo a "certain amount of reorganisation". Phases 2 and 3 are consistent with earlier accounts of the beginnings of representational intelligence (i.e. the development of explicit similarity or equivalence relations between individual objects). However, Phase 4 exceeds the simple interobject comparison involving co-ordination, whereas, according to Piaget, the implication is that at least until four years " ...conceptual constructions remain at the level of piecemeal comparisons or 'successive assimilation' of individual elements ..." (Sugarman, 1982b, p. 88). Nevertheless, these co-ordinations do not entail deduction - they are still a perceptual strategy, not conceptual transformations which involve transitive inferences (i.e. if  $a = b$  and  $b = c$  then  $a = c$  is an example of a transitive inference involving the derivation of a third relationship; the child who is co-ordinating comparisons would infer if  $a = b$  and  $b = c$  then  $a$  is related to  $b$  in the same way that  $b$  is related to  $c$ ). Research on preschool children indicates that they are unable to reason transitively.

#### 1.2.6. Other Evidence for Co-ordination of Interobject Comparisons

##### 1.2.6.1. Class inclusion studies

If young children were shown to be able to hierarchise objects into subordinate and superordinate categories,

this would indicate co-ordination of interobject comparisons. However, most studies indicate very basic hierarchisation in the preschool years and a tendency to use basic level categories (e.g. Markham and Siebert, 1976; Sigel, 1964). Children's use of language categories is very misleading as they appear to understand superordinate categories, e.g. a dog is an animal (Flavell, 1963).

Studies aimed at revealing gaps in the child's understanding of superordinate/subordinate class relationships using the famous "some and all" experiments, e.g. are there more primulas or more flowers? when presented with an array of more primulas and fewer of another type of flower, indicate that the child has mastered these rules during the early to middle elementary school years (Inhelder and Piaget, 1964; Kofsky, 1966 and Flavell, 1970 cites many others). In a provocative article, Siegel (1977) suggests that the poor performance of younger children on this task is the result of confusing language cues. A study by Siegel, McCabe, Brand and Matthews (1978) claims to have shown class inclusion with three- and four-year olds. Children faced with an array of two kinds of sweets, smarties and jelly beans, were asked which they would rather eat - the smarties or the candy. Many who could not answer the more traditional question "are there more smarties or more candies?" were able to choose to eat the candy. This study has not tapped all the aspects of class inclusion and simply indicates that these children were

aware that the class of candy is larger than the class of smarties. There is no indication whether children can infer that as there are types of candy that are not smarties, the class of candy must be larger than the class of smarties. Furthermore, the three-year olds in Siegel's study only coped with the question when there was a low numerical discrepancy between subsets and the sets had smaller sizes. This indicates a strong reliance on perceptual factors.

Despite her reservations of the verbal nature of the task and the limited conclusions that can be drawn about the child's logical inference, Sugarman (1983) has presented some exchanges with her subjects which are along the same lines. She found that children could evaluate objects on the basis of two dimensions of variation and when something was grouped or labelled incorrectly, reject the wrong, e.g. asked "Are all the blocks red?" they could proceed, item by item, to check whether they fitted the description and if not, name the incorrect object - blue block. However, this does not indicate that they understood the reversible relationship (all the red blocks are some of the blocks).

#### 1.2.6.2. Bidimensional classification

Additional evidence suggesting that children in this age range or a little older may be able to co-ordinate values comes from studies of multiple classification. Odom,

Astor and Cunningham (1975) found that four-year olds could co-ordinate values of highly salient sources. Some children in their fourth year have been shown to co-ordinate form and colour (Colby and Robertson, 1942) or form and size (Denney, 1972) and Sugarman (1983) found this co-ordination of form and colour in half her subjects by two-and-a-half years. There is also evidence of a consistent anticipatory approach to bidimensional classification (Campbell, Donaldson and Young, 1976), especially when there was high within class perceptual similarity.

The role of greater salience of one dimension, usually form over colour and size in the preschool years (Brian and Goodenough, 1929; Casey, 1979; Sugarman, 1983; Smith, 1979), may provide a network within which the other dimension can be classified. Sugarman (1983) suggests, on the basis of Fischer and Roberts (1980, cited by Sugarman, 1983, p. 11), that the consistent grouping results from not processing other dimensions, a point of view similar to that expressed by Campbell et al (1976) that colour is easier to ignore as a salient attribute in this age group but becomes less so with age, accounting for the initial drop off in performance on matrix tasks noted in six-year olds in the Inhelder/Piaget study (1964). These studies do suggest that perceptual factors play a large role in the performance of the young child on multiple classifications (Inhelder and Piaget, 1964; Bruner and Kenney, 1966), but Sugarman (1983)

argues persuasively that the notion of perceptual strategy is insufficiently analysed. She points out that in choosing a new object for a construction in progress, or in placing it, children make judgements which could involve more than one comparison. These strategies appear, however, to be on a move-to-move basis, the whole structure is not represented at once. Nor does reliance on perceptual supports lessen the need for the child to co-ordinate comparisons - each object is evaluated in relation to another on the basis of both dimensions. This and evidence that children can be trained to attend to two dimensions of an object in the third year (Watson and Danielson, 1969; Watson, Hayes and Vietze, 1979) suggests that the view that the child between two and four categorises "on the basis of single characteristics of objects and is unable to classify the multifaceted aspects of stimuli" (Sigel, 1964, p. 217) is only partially true.

#### 1.2.7. The Cultural Context of Studies of Early Grouping Behaviour

It should be noted (and this point will be returned to in 1.3. below) that all these studies have been conducted in Europe, Britain and the United States usually, if it was specified at all, with middle-class subjects. The findings have, however, been presented in terms of the operation of universally present cognitive structures. This focus has excluded the "wider sociocultural framework of behaviour" (Jahoda, 1982, p. 32) which has been shown

to have an enormous influence in determining performance on a wide range of cognitive tasks (e.g. Dasen, 1972, Furby, 1980). As such, it presents a serious limitation to knowledge about early grouping behaviour

In summary, the preceding section explained that grouping behaviour is seen as evidence of the operation of the logical structures which provide the basis for thinking and as such, touches every area of concept development. Traditional approaches by Werner, Vygotsky and Piaget were compared and examined in relation to more recent studies of grouping by children in the first three years. It was argued, drawing evidence from Sugarman's work and studies of class inclusion and bidimensional classification, that children in this age range may be capable of more co-ordination of concepts than Piaget's theory allows. Finally, the limitation on the universality of these conclusions in terms of cross- and sub-cultural applicability was noted.

### 1.3. ENVIRONMENTAL EFFECTS ON GROUPING BEHAVIOUR

Thus far the development of classification skills has been discussed in terms of universal cognitive structures in the child, the emphasis of the theorists reviewed. In this section the role of environmental factors on the development of grouping behaviour is considered. The

discussion deals with the following two related aspects:

- (1) Effect of specific task variables on grouping behaviour, and
- (2) Effects of sociocultural factors on performance on grouping tasks.

As was mentioned in 1.2.7., the studies reviewed above have almost all had middle-class subjects from modern industrialised countries and most researchers discussed their findings in relation to a Piagetian framework. While Piaget (1966, 1970) specifically states that his approach to cognitive development is interactionist, it has justly been pointed out that his explanatory constructs have focussed on the organism (Fischer, 1978; Furby, 1980; Jahoda, 1982), to a large extent assigning a minimal role to the effects of environmental factors on development.

As the studies have largely been conceived from the point of view of middle-class Western notions of intelligence, the influence of general environmental characteristics on the stages through which grouping behaviour progresses has not been considered, though the effects of specific task characteristics have received some attention.

### 1.3.1. Effect of Specific Task Characteristics on Determining Performance on Grouping Tasks

Quite small alterations in context have been shown to change children's performance on grouping tasks.

Inhelder and Piaget (1964) note the role of verbal instructions on grouping. If they asked subjects to put together things that were alike, the groupings formed tended to be based on similarity and relations of resemblance. If the instruction was to put together whatever goes together, subjects more often produced collections based on syncretic ideas of belonging.

Similarly, Denney (1972) found that differing instructions influenced the variety of groupings produced by subjects. These differences are even more marked in cross-cultural studies where convention and tradition have been shown to influence or determine the type of responses to logical problems (cf. Ghuman, 1981; Glick, 1975), as has the familiarity of materials used in the tasks (Glick, 1975; Okonji, 1971).

The role of stimulus preference or salience in performance on grouping and categorising tasks of various kinds has been the subject of a number of studies. This is particularly relevant in the study of early grouping as sequential selection or spatial placement of objects from the same group may not reflect the search for similar objects but simply the choice of more salient items.

Saliency has been noted in most studies of early grouping (e.g. Ricciuti, 1965; Ross, 1980; Sugarman, 1981) and shown to affect the frequency of grouping behaviour (Nelson, 1973; Starkey, 1981) and the ease with which multidimensional classification problems are solved (Odom and Corbin, 1973; Odom, Astor and Cunningham, 1975; Odom, 1978). A number of different characteristics of objects have been shown to facilitate grouping. Several studies have shown form to be a more salient principle of organisation than colour in the first three years (Brian and Goodenough, 1929; Colby and Robertson, 1942; Casey, 1979; Descourdes, 1914; Sugarman, 1983) though contradictory evidence comes from Brill (1981) who found colour or surface texture more salient at all ages from 12 - 45 months. Studies of African subjects ( $\pm$  7-11 years) suggest that colour is a more salient dimension (Glick, 1975) but age groups are not comparable.

Function of the objects is salient under many conditions (Daehler and O'Connor, 1980; Holland, 1978; Nelson, 1973, 1979), though other studies suggest that grouping by similarity is more common in this age range (Lee, 1965; Sigel, 1964). Many studies of non-Western subjects find that function is a most salient principle of organisation at all ages, though these studies were with older children (ages  $\pm$  7 - 11 years). A general finding is that stimulus novelty is an important variable (Daehler and O'Connor, 1980; McCall, 1974; Ross, 1980), generally causing an increased tendency to manipulation and exploratory

manipulation or recovery of visual attention in an habituation task. Hunter, Ross and Ames (1982) suggest that a key situational variable in this regard is length of familiarisation time. A conflicting finding on the novelty theme (Schaffer, Greenwood and Parry, 1972) was that older infants had some hesitation about contacting unfamiliar stimuli.

Ricciuti's (1965) finding that the number of dimensions of difference between objects on a categorisation task is related to the amount of grouping behaviour, is supported by Smith (1979) who found that overall similarity of items is what children use to classify and that maximising between class differences increases classification.

This complex of results with subjects in different age groups produces no readily analysable picture though clearly the role of stimulus determinants in eliciting cognitively organised behaviour is very great.

#### 1.3.1.1. Stimulus prototypes and natural categories

In the studies of Euro-American subjects, no particular reference is made to sociocultural factors which might well influence the relative salience of objects. It appears that there is a great deal of implicit support for a view of universally salient stimulus prototypes. Prototypicality is " ... the quality of a single stimulus/or select few stimuli in a given sensory domain to stand out as preferred" (Bornstein, 1981, p. 44).

These prototypes are recognised more quickly, processed faster and draw attention to a class or domain, clarifying and identifying it from others. Perceptual organisation of this kind has obvious survival value and is even found in the simplest organisms. Bornstein suggests that prototypicality may be species specific but implies that it would be constant within a species. Rosch (1976), working with Dani of New Guinea who initially did not have form and hue concepts, in teaching them found evidence for non-arbitrary colour and form categories formed around perceptually salient natural prototypes. She suggests that other domains are also organised into natural basic categories and there is some evidence to suggest this. For example, the model can account for classifications in various studies of taxonomies (cf. Jahoda, 1982, p.247). Jahoda does, however, cite evidence that Rosch's results were partly a function of the particular set of objects, and Dougherty (1978) suggests that basic object levels are relative and determined by the extent of the individual or culture's interaction with the particular domain.

It is likely that certain stimulus prototypes are universal. Forman (1982a) suggests that a closer look at how the "physical properties of a class of objects define a constrained range of possible significations" which activate certain schemes but not others (p. 335), could account for the development of symbolic universals.

Gibson (1979) also refers to this "affordance" of objects. Other prototypes are more dependent on sociocultural factors. Knowledge of the influence of sociocultural factors on the relative salience of objects could help account for cross-cultural and social class differences in performance on grouping tasks.

### 1.3.2. Sociocultural Effects on Performance on Grouping Tasks

Broader environmental influences such as social class and culture have been shown to play a large part in determining performance on a variety of cognitive tasks. Cross-cultural studies and those of different social classes will be discussed together. However, the joint discussion does not reflect the view that there is a uniform "culture of poverty". This term, first used by Oscar Lewis (H. Lewis, 1966) reflects the concept that poverty is a radically different culture from the middle class with a lifestyle passed from one generation to the next.

Studies of grouping in different cultures and social classes have been sparse, particularly in the early representational period that is the intuitive phase of the pre-operational period. To broaden the base of studies considered, grouping studies among concrete operational children have been included in the review, as have studies of other logical tasks. As grouping is such a central part of cognition, performance on other cognitive tasks should give some indication about possible sociocultural differences.

Following Berry and Dasen (1974) there are two questions to ask in comparing the development of classification and other cognitive skills cross-culturally: firstly, whether or not there are qualitative differences (do stages appear in the same sequence), and secondly, whether or not there is quantitative variance (does the rate of cognitive growth change under the influence of culture or social class).

#### 1.3.2.1. Cross-cultural studies of classification and concept development in the preschool child

Seltzer (1971) tested middle- and lower-class (predominantly rural) American infants aged three months to two years on a two choice preference task. Objects varied in form, colour and position and one was chosen at a time. Children were evaluated for consistency in choosing a particular colour, form or position. There were no social class differences or dimensional preferences.

These results are consistent with findings of studies of social class differences in infancy which used intelligence tests. Bayley (1965) found no differences under one year, nor did Messer and Lewis (1972). Golden and Birns (1968) found no differences between middle and lower socio-economic strata in the second year, but differences have been widely reported by the end of the third year (e.g. Golden, Birns, Bridges and Moss, 1971; White, 1975). Earlier differences were observed in a study by Biersteker and Short (1975) who found a positive correlation between levels of socio-economic status within a poverty group and scores on the Bayley Scales of Infant Development (Mental Development

Index) for infants aged 11 to 29 months. Golden and Birns (1976) note that cognitive measures involving language are related to social class as early as the first year.

Evidence of social class differences after the third year is seen also in studies of classification where poor children aged five to seven years were slower to develop classification, matrix solving skills and changing criteria for grouping (Wei, Lavatelli and Jones, 1971). Overton, Wagner and Dolinsky (1971) also found social class differences in classifications of preschool children.

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Cross-cultural research on infancy indicates in general "that normal infants in culturally normative care display the same critical cognitive development at about the same time the world over" (Super, 1981, p. 27). Studies of infants using tests derived from Piaget's theory indicate that stages are reached in the same order (Dasen and Heron, 1981). Super reports an extensive study by Dasen and associates of infants of 5 to 31 months in rural villages on the Ivory Coast. A remarkably similar developmental sequence to that of Swiss and French children has been found, with infants from the Ivory Coast combining objects and using objects to get other objects earlier than European infants. Other studies reviewed by Super indicate a similar pattern.

In infancy, at least, differences appear to be minimal but to increase after the first and second year. Rebelsky and Daniels (1976) comment that it is precisely at this stage that items for tests begin to be based on more

Western notions. Secondly, there may be more wariness of the experimenter and the demands of the testing situation. While many would accept that their point is valid with regard to intelligence tests and the testing situation, Piagetians have held their stages to be universal. Critics who feel that it too is an ethnocentric approach (e.g. Buck-Morss, 1975; Greenfield, 1976) point out that differences between classes and cultures emerge once the concrete psychomotor stage is over and the abstraction valued in Western thought becomes important.

#### 1.3.2.2. Cross-cultural studies of classification and concept development in the concrete operational child

Studies of cognitive development in this period suggest that there are no qualitative differences between groups, but that there are variations in the rate of development of these skills. Sinha (1982), reviewing studies of perceptual and cognitive development of Indian children of different castes and socio-economic status compared with Euro-American subjects, concludes " ... while deprivation may affect levels of competence on a particular skill, it seems not to affect the pattern or sequence with which the skill develops" (p. 465). Ohuche and Pearson (1976) conclude that research on conservation and classification in Africa shows increasing use of abstraction with age but that performance depends on the familiarity with the materials to be classified and the bases of classification. Glick (1975), reviewing cross-cultural studies of concept development, finds "though some studies suggest cultural

differences in concept structure, the differences have been found to be minimal" (p. 631). Similarities or differences between African and Western groups depend greatly on the particular experimental arrangement used (Cole, Gay, Glick and Sharp, 1971; Derogowski and Serpell, 1971; Okonji, 1971).

Other studies have found clear differences in the rate with which stages were acquired. De Lacey (1970) based his study of classification in 6- to 10-year olds on Inhelder and Piaget's tasks. He compared European children of high and low socio-economic status and Aborigine children with high and low contact with Western influences. Performance increased for all groups with age and the developmental stages were constant. On all tasks the order of achievement was high socio-economic status Europeans, low socio-economic status Europeans, high contact Aborigines and low contact Aborigines. His results suggest that the parallel development of additive (unidimensional) and multiplicative (multidimensional) classification may only occur when the child's environment provides opportunities for this growth. Price-Williams (1962) found that Tiv children, aged 7 to 16 years, showed a lag in the development of classification.

For concept development as a whole, Dasen (1972) notes that a number of studies show that both non-Western and low socio-economic children lag compared to middle-class Western children. The restricted age range of many studies results in many cases in uncertainty whether or

not the particular concept is ever attained by the group being studied.

### 1.3.3. Factors Affecting Competence on Cognitive Tasks

Two kinds of influences on the rate of development which have received attention in cross-cultural studies are schooling and urban experience, both seen as opportunities for contact with the Western cognitive values inherent in Piaget and other approaches to cognition.

Performance on classification tasks in particular could be affected by schooling. Rogoff (1981) notes that in comparison with non-schooled subjects, schooled subjects are more likely to classify systematically on the basis of taxonomic categories rather than function, or form rather than colour of geometric or unfamiliar stimuli. Differences may reside in the ease with which the task is understood, the subject's ability to take the same viewpoint as the experimenter and so forth.

Urban experience has been shown to affect performance on classification and other cognitive tasks (Sinha, 1982; Glick, 1975). For example, the ability to change the basis of categorisation is related to extent of urbanisation (De Lacey, 1971; Maccoby and Modiano, 1966; Ghuman, 1978) though there is some conflicting evidence from Greenfield (1966) who found that the performance of bush-schooled children was in advance of city children till 11 - 13 years; and some studies have found little influence (e.g. Price-Williams, 1962; Goodnow, 1962).

Degree of Western contact may have value in explaining cross-cultural differences but not social-class differences within the same culture. A variety of alternatives has been suggested to account for these. Jensen's (1969) work exemplifies the "genetic-deficit" approach which argues that a substantial part of differences in school performance among different socio-economic strata and ethnic groups is accounted for by genetic differences. As Bee (1978) points out, no findings actually exclude genetic variation as an explanation of group differences, but evidence on the effects of environmental variations suggests that a large part of class differences is due to environmental factors.

Research on the nutritional and health status of the poor (e.g. Birch, 1968) suggests that this is one factor which contributes to differences though it is difficult to isolate physiological causes from other contributory factors. In general, Dasen, Lavallee, Retschitzki and Reinhardt (1977) note "there is consensus that severe malnutrition affects intellectual development especially if it occurs in the first six months or possibly the first two years" (p. 146). Their study compared the performance on tasks based on Piaget's sensorimotor stage of two groups of culturally and socio-economically equivalent Baoule (Ivory Coast) infants aged 5 to 33 months who were either adequately nourished or moderately malnourished. Though the results are difficult to interpret, some differences between the two samples were statistically significant. This suggests that even moderate levels of

malnutrition may affect performance on cognitive tasks.

Buck-Morss (1975) proposes that lower class children like children of non-Western cultures do not have the opportunity to consciously participate in the abstract levels of Western society which brings the ability to reason in abstract terms. Other environmental factors which have been looked to as accounting for differences include the type and amount of home stimulation for different social classes (e.g. Tulkin, 1970, cited by Bee (1978) p. 250; Yarrow, Rubenstein, Pederson and Janowski, 1972), style of social interaction (e.g. Hess, 1970; Hess and Shipman, 1965, 1967; Clarke-Stewart, 1973; Tulkin, 1970) and differences in language modes (Bernstein, 1970; Kagan, 1970; Schacter, Marquis, Bundy and McNair, 1977).

This section has examined studies of environmental effects on the development of classification and other concepts. While many researchers focus on the universals of behaviour rather than the differences (e.g. Super, 1981; Ginsburg, 1972; Glick, 1975) and it is clear that all children acquire certain basic categories of thought, it is evident from the studies reviewed above that there are some differences which require explaining. Even if it is only the rate of development that is slower for certain groups, this could, as Bee (1978) suggests, have profound effects on school performance and motivation. It seems reasonable to suggest, along with researchers like Ghuman (1982) and

Kagan (1973), that as long as different cultures and social classes compete for positions in industrialised society there will be a place for these comparative studies, however ethnocentric they may be. However, greater understanding of the cognitive competencies required under other sociocultural conditions indicates the relativity of many cognitive skills previously held to be universal standards against which all performance was measured. All the evidence reviewed in this section suggests, as Fischer (1978) has said, that we need to regard cognitive structures as jointly determined by the actions of the organism and the environmental context that supports those actions. He has proposed that transactions between the organism and environment give rise to specific skills and if the environment changes, so does the skill concerned. This would certainly account for the influence of task characteristics on performance on a cognitive task, and the way that cross-cultural differences are present under certain testing conditions and not others.

#### 1.4. THE PRESENT STUDY

*Re: male*

From the literature reviewed above, it becomes apparent that very little is known about the effects of sociocultural variables in the early representational period. Studies measuring infant intelligence indicate that it is during this period that cultural and social class differences begin to emerge but there are no

cross-cultural or cross-class studies of fundamental cognitive skills such as categorisation.

This study was therefore designed to investigate object grouping in a different social class. As the subjects for the study are lower-class coloured children, it must be clarified that though they are politically designated as a separate ethnic group in South Africa, there are not sufficient grounds for seeing them as a separate cultural group (see 2.1.), nor is lower social class seen as a "culture of poverty". The aim is simply to describe the development of this skill in lower-class children in the intuitive phase of the pre-operational period to provide a basis for comparison with previous studies of middle-class children.

In particular, the study will test for evidence of the four phases of interobject comparison postulated by Sugarman (1982a and b, 1983), and identified by her move-by-move method of analysis.

When the study was planned, it was decided to extend Sugarman's reported work by including a test of bidimensional in addition to unidimensional grouping. Subsequently, however, she published her study of bidimensional grouping in this age group and the results of this study will be compared with her findings (Sugarman, 1983).

Task effects have been shown to have a substantial influence on performance on grouping tasks within and across cultural groups, and a second aspect of this study will be to

investigate whether there are differential task effects on the grouping behaviour of young children from low income families. Differential effects of the same stimulus materials have been most obvious in different cultural groups. As the lower-class children in this study are all urban, it is likely that differential task effects will be similar for them and the middle-class urban children tested in previous studies.

Findings of differential social class effects on competence on various tasks present some difficulties of interpretation. Cole and Bruner (1971) note the enormous effect of the situation and context in which the competence is expressed on performance. Flavell and Wohlwill (1969) have distinguished two kinds of competence: the first being the rules, structures or mental operations embodied in the task, and the second, the actual mechanisms required for processing input and output. Performance will reflect both of these and, with age, both will increase.

In designing this study, care will be taken to reduce those contextual factors known to adversely affect the performance of young lower-class children. Secondly, the analysis will look at subjects' highest level of performance in addition to their average level. Should these differ, examining best performance will suggest the level of underlying skill, examining average performance may reveal something about situational effects on the lower-class child's performance.

This study was designed in order to examine the following questions:

The major question was whether the performance on grouping tasks of this sample of lower-class children in a day care situation would differ from previously studied middle-class groups in the age range of 18 months to 3 years.

In addition, it was hypothesised that different materials would elicit differential grouping behaviours but it was expected that these would be the same for this sample of lower-class children and previously studied middle-class children as both came from Western industrialised societies.

Particular hypotheses in relation to age and subtleties of grouping behaviour will be considered when discussing the results of each section of the study.

## 2. METHOD

### 2.1. DESIGN

2.1.1. Criteria Governing the Choice of Subjects

2.1.2. Criteria Governing the Choice and Presentation of Materials

2.1.2.1. Materials

2.1.2.2. Order of presentation

2.1.3. Choice of Experimenter

2.1.4. Test-retest Reliability

2.1.5. Measures of Grouping Behaviour

### 2.2. PROCEDURE

2.2.1. Experimental Situation

2.2.2. Spontaneous Play

2.2.3. Elicitation Tasks

2.2.3.1. Elicited grouping task

2.2.3.2. Misplacement task

### 2.3. ANALYSIS

2.3.1. Coding and Scoring

2.3.2. Choice of Statistical Tests

## 2. METHOD

### 2.1. DESIGN

The study is divided into two parts with separate analyses based on the same data pool.

(1) Part One examines age effects on the grouping behaviour of young children from low income families.

(1) Part Two examines task effects on the grouping behaviour of these subjects:

#### 2.1.1. Criteria Governing the Choice of Subjects

Subjects for this study were coloured children from the housing area of Kewtown. The term "coloured" is used in the unique South African sense to denote persons of "mixed descent". Essentially the coloured people are of Western orientation and fall into the same cultural stream as white South Africans in terms of language, housing, dress, occupations, education (Cilliers, 1963; Kessel, 1972). It is therefore a study of social class differences not ethnic differences.

Kewtown forms part of the municipality of Athlone, some eight miles north east of the city of Cape Town. It is zoned for low income housing for coloured families. These families are characterised by low parental education levels, semi- or unskilled occupational status,

low family income and a high degree of overcrowding in housing conditions (Biersteker, 1979; Manidis, 1975). This pattern is typically found in many housing areas in the Cape Peninsula and conforms to the pattern of disadvantaged urban communities found in large cities around the world (Kessel, 1973).

It was decided to restrict the choice of subjects to those who had contact with the staff of the Athlone Early Learning Centre (ELC), a project serving families in Kewtown. This was necessary to ensure a group of subjects whose performance would be least affected by an unfamiliar testing situation. The effects of situational variables on the performance of very young children, in particular children from low income families, have been well documented (Bronfenbrenner, 1979; Cazden, 1970; Evans, 1974; Hilliard, 1975; Sroufe, 1970; Tulkin, 1972; Zigler and Butterfield, 1968).

A comparison of the findings of a survey of families on the ELC waiting list in 1972 and 1973 (Biersteker, 1979) with an independent survey of Kewtown families (Manidis, 1975) indicated that families served by the ELC are in general representative of families in Kewtown. The samples were comparable with respect to income levels, occupational status, educational levels, religious affiliations, housing conditions and arrangements for the care of preschool children.

Despite the fact that the samples are comparable, the choice of subjects attending a preschool centre

introduces the variable of programme effects. ELC programmes aim to promote overall development and there is no specific concept training, however there is the possibility that participation in the ELC programmes might provide indirect experiences that would give subjects an advantage on tasks of this kind. For example, children who have attended the ELC for some time are more socially responsive and verbalise more than their peers once they start formal schooling (Short and Biersteker, 1977). Any advantage would apply more especially to the older subjects who have had a longer exposure to the programme. This will be borne in mind when generalising the results. However, it should be noted that the use of samples of children from day care centres in examining social class differences on various aspects of development is not uncommon (e.g. Lesser, Fifer and Clark, 1965; Wei, Lavatelli and Jones, 1971) and the consistent quality of care and daily stimulation in such settings may reduce other sources of variation found in studies of this kind. Restricting the sample to children from the ELC meant that the number of subjects was limited. It was therefore necessary to depart from the usual practice in studies of grouping (cf. Ricciuti, 1965; Ross, 1981; Starkey, 1981; Sugarman, 1983) of dividing the sample into discrete age segments (e.g. 12 months, 18 months, 24 months). Instead age groups are divided into continuous ranges. As developmental level varies greatly between individuals of the same chronological age, this was considered to be

justifiable, particularly as age ranges within groups were small.

Likewise, it was not possible to balance the sexes of subjects within age ranges, but previous grouping studies have found no significant sex effects (Denney, 1972; Ricciuti, 1965; Ross, 1980; Starkey, 1981; Sugarman, 1982a and b).

As the number of subjects was limited, they were carefully screened for any abnormalities that might affect performance. Medical records examined included birth history, hospitalisations and serious illnesses and quarterly mass and height readings. The supervisory nursing sister and other staff members were also queried about the home circumstances of the children. Finally, records of family income, housing, occupation and parental education were consulted to ensure that all subjects' families fell within the lower-class parameters defined in a socio-economic index developed by research staff at Athlone ELC (Early Learning Centre, 1972 - see Appendix A).

In general, the pattern of hospitalisation for gastro-enteritis, single parent families was typical of such communities and it was considered that exclusion of subjects on such grounds would detract from the representativeness of the sample.

SUBJECTSTable 1: Description of the Four Groups of Subjects

<u>Group</u>	<u>N.</u>	<u>Age in Months</u>			<u>Length of Attendance</u>			<u>Sex</u>	
		<u>Range</u>	<u>Mean</u>	<u>S.D.</u>	<u>Range</u>	<u>Mean</u>	<u>S.D.</u>	<u>M</u>	<u>F</u>
A	8	16-23	18,6	2,5	3-11	6,2	2,9	3	5
B	8	24-30	26,5	2,2	3-12	8,9	3,6	4	4
C	8	31-36	32,4	1,3	5-24	11,5	7,5	5	3
D	7	37-42	39,9	2,7	3-27	16,6	9,2	3	4

The 31 subjects were divided into four groups as shown in Table 1. The recorded age of each subject was estimated within two weeks of his chronological age. Thus, at 16 months and 2 weeks the subject was recorded as 16 months, and at 16 months and 3 weeks as 17 months. Twenty-eight subjects attended the preschools at the Athlone ELC and three subjects were enrolled in an educational homevisiting programme run by the Centre. Only one subject appeared to be nutritionally at risk, that is, below the 3rd centile for mass and height (Cooke and McDonald, 1980), but her general responsiveness and behaviour gave no indication that she was adversely affected and, as the subject pool was small, she was included. All subjects' families conformed to the low socio-economic pattern. Seventy-five percent of the sample were below the supplemented income level and one-third below the minimum income level for coloured families in urban areas (Bureau of Market Research, Unisa, 1983).

### 2.1.2. Criteria Governing the Choice and Presentation of Materials

Six different sets of materials were presented. This would allow an examination of the effect of task characteristics on performance and also increase the likelihood that subjects would engage in some grouping behaviour to furnish data for Part One of the study. Materials were selected to be comparable with certain sets of objects used in previous studies, and were pilot tested to ensure that they could sustain children's interest. Following previous studies (Nelson, 1973; Ricciuti, 1965; Starkey, 1981; Sugarman, 1982a and b), material sets contained eight objects, four from each of two classes. The simplicity of the object sets was intended to increase the probability that all children would group in a class consistent way and to limit the ways in which objects could be divided into two subgroups. This would generate a small and comparable variety of groupings within the subjects.

Two tasks used materials of geometric solids of the type used by Ricciuti (1965) and Starkey (1981). Two tasks used replicas of real objects to investigate grouping by function following Nelson (1973). The materials for the remaining two tasks were based on objects used by Sugarman (1982a, 1982b). One used a combination of real and geometric objects. The other extended her cylinder/column task so that there were two dimensions (colour and form) to be considered when grouping. This was done to

investigate the ability of children in this age range to form bidimensionally consistent groupings. Subsequently published work by Sugarman (1983) reports her findings in this area and extensive use has been made of her coding categories in interpreting findings in this study.

#### 2.1.2.1. Materials

The object sets illustrated in Figure 1, were as follows:

Task I: Doll-size eating utensils, comprising a cup, fork, knife and spoon (cutlery: length approximately 8 cm; cup diameter: 1,5 cm) and plastic cars with slight differences in form and colour (8 x 4,5 x 4 cm).

Task II: Cylinders and columns (8 x 2 cm) in green and white (form and colour crossed).

Task III: Yellow triangles and yellow hexagons (surface area of both 49,5 cm).

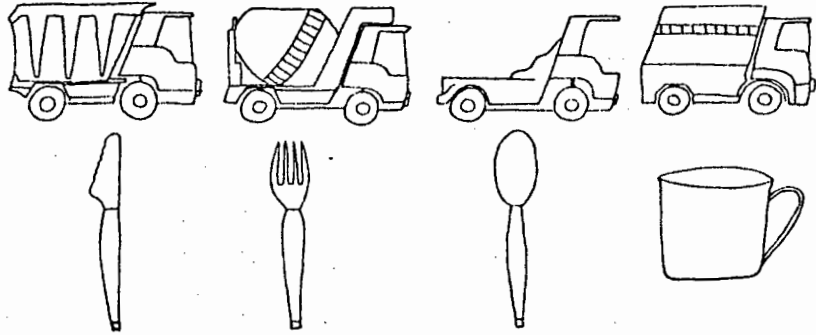
Task IV: Silver plates (diameter 6,5 cm) and square white blocks (2 x 2 x 2 cm).

Task V: Finger puppet animals of different types and colours (8 x 4 cm), and miniature dollhouse-size furniture, comprising a bed, cupboard, table and chair (approximately 8 cm high).

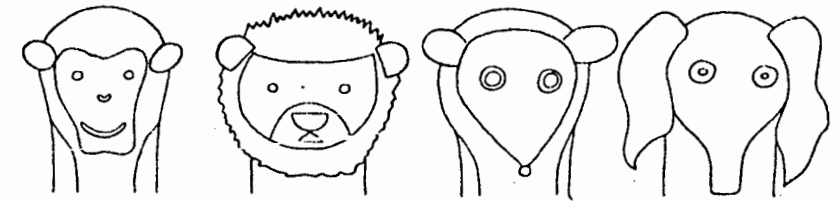
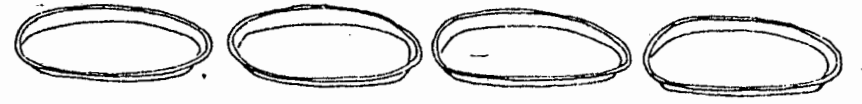
Task VI: Red and blue balls (diameter 3 cm).

Materials were made out of wood, plastic or felt (the animals). For Tasks II, III, IV and VI items within the same class were identical in shape. In Tasks I and V items within the same sets were all different.

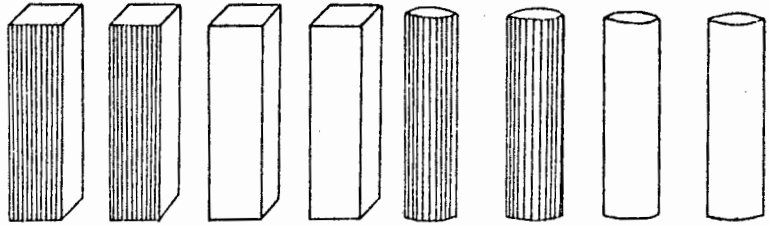
TASK I



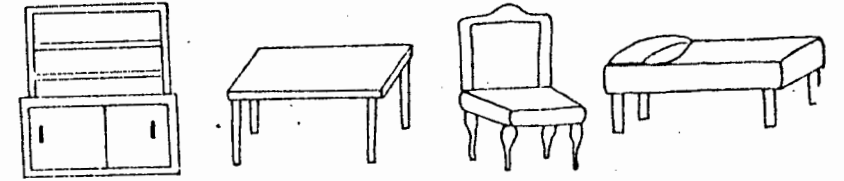
TASK IV



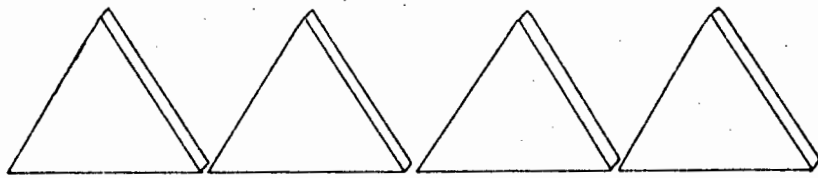
TASK II



TASK V



TASK III



TASK VI

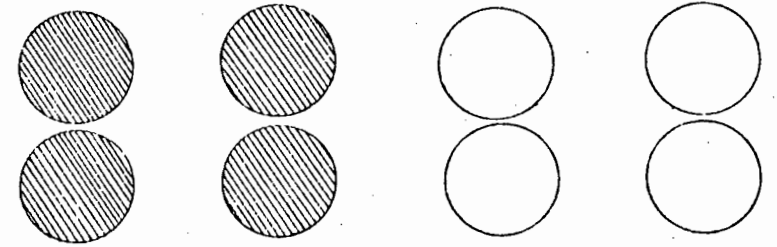


FIGURE 1. SCHEMATIC DRAWINGS OF TEST OBJECTS

#### 2.1.2.2. Order of presentation

The tasks were presented in three orders, counterbalanced for each age group. Presentation order was varied to control for fatigue effects on particular tasks. The orders given in Appendix B were designed so that Tasks II and IV (which were followed by elicited grouping probes) were not successive, and each half included one task with real materials.

#### 2.1.3. Choice of Experimenter

In order to prevent strangeness of the experimenter from inhibiting subjects' performance, it was necessary that a familiar figure presented the materials. However, it was also important not to bias their performance with expectations based on their day-to-day behaviour. It was therefore decided that the author would present the materials. She was a familiar figure to the subjects but not involved in their daily care or teaching. However, she was white and a different social class - factors which have been demonstrated to affect performance in test situations with older children and adults (Rosenthal and Rosnow, 1969). Studies have indicated that children only begin to recognise ethnic characteristics from around three to four years (Goodman, 1964; Lasker, 1929) and experience at the Early Learning Centre suggests that for very young children, familiarity is more important than controlling for skin colour and social class.

#### 2.1.4. Test-retest Reliability

As a partial test of the stability of subjects' performance with these materials, an age-stratified random sample of ten subjects was retested on two elicitation tasks. Testing took place three weeks after the original sessions.

Test-retest reliability was computed using Spearman's rank order correlation and yielded a coefficient of .61 on elicited grouping and .34 for the misplacement task. These values are not significant for the small sample, but on the elicited grouping task all but one subject, who improved, maintained their original level of grouping. There was considerable variation on the misplacement task, as many subjects showing a deterioration as those who improved, but this is attributable to the ambiguity of cues in this task and to carry-over effects from the elicited grouping task. On both tasks the lack of obvious training effects is apparent.

The results suggest that grouping behaviour tested was stable as long as children understood the cues inherent in the situation and it is apparent from the high percentage of consistent constructions that subjects did so.

#### 2.1.5. Measures of Grouping Behaviour

It was decided to base the major analysis on what subjects did spontaneously when given an opportunity to manipulate the materials. This method has been preferred to more structured techniques in recent studies of early grouping

behaviour (Ricciuti, 1965; Starkey, 1981; Sugarman, 1981, 1982a and b, 1983) for two reasons:

(1) It generates information about how children naturally organise objects rather than about what they can do when their thinking is manipulated in a certain way, thus giving some clues about their cognitive processes.

(2) It overcomes problems of understanding verbal instructions, especially by younger children, which makes it difficult to compare their performance with that of older children. (Ricciuti notes an earlier study in which younger children who failed to show any categorising behaviour in response to verbal instructions spontaneously manipulated categories of objects.)

The non-verbal task is also most appropriate for lower-class subjects, as previous research suggests that it is precisely when tasks require more verbalisation that the scores of young lower-class children begin to differentiate from those of middle-class children (cf. Golden and Birns, 1976).

The following measures of the dependent variable were used (detailed categories are given in Chapter 3):

(1) Sequential Ordering:

This was a measure of "temporal grouping" (Ricciuti, 1965), given by the sequence in which objects of different classes were touched or handled. It was included as younger children who fail to produce spatial groupings have been shown to group temporally (Ricciuti, 1965; Starkey, 1981).

(2) Spatial Products:

This measure, commonly used in studies of grouping (Inhelder and Piaget, 1964; Nelson, 1973; Ricciuti, 1965; Starkey, 1981; Sugarman, 1982a and b/1983), examined the type and complexity of spatial arrangements of objects (constructions) produced by each subject.

(3) Grouping Procedure:

Grouping procedure, a measure developed by Sugarman (1982, 1983), looked at the order in which objects from different classes were manipulated in the construction of spatial arrangements.

## 2.2. PROCEDURE

### 2.2.1. Experimental Situation

Testing took place at the Athlone Early Learning Centre in a research room which looked out onto the outside play area, familiar to the subjects. Subjects were fetched from their playrooms by the experimenter, and if they showed any hesitation or if their particular caregiver felt it was necessary, she too accompanied them and was present during the testing. This happened in six cases, all subjects of 25 months or younger. The three subjects from the home visiting programme were accompanied by their mothers. Subjects were not tested on a day when staff observed that they were tired or off-colour, or at any time when they were reluctant to leave the playroom.

The subject was seated on a box (40 x 40 x 40 cm) across a low table (91 x 50 x 45 cm) from the experimenter, who was seated at the same level as the subject. If a second adult was present, she sat on the subject's left. A few of the younger subjects were seated on their escort's lap. A technician video-recorded the session with sound, with a video camera placed behind a one-way mirror and a microphone placed unobtrusively near the subject.

The escort was told that the experimenter was interested in the ways that young children spontaneously manipulate objects and that she was not to intervene, though she could give general non-selective encouragement (e.g. "Mooi", "Um", "Lovely").

After a brief warm-up period of about three to five minutes in which some materials were made available (playdough, plastic animals, large plastic beads) to encourage manipulatory activity, the six tasks were presented. Two of these were followed by elicitation tasks. All of this took place at the table and the test sessions, including familiarisation time, presentation of the different items and pack-up between tasks, took roughly 20 to 25 minutes. This time span seemed to be within the attention span of most of the subjects. Verbal instructions to subjects all followed Sugarman (1982a) and were given in their home language, either English or the local Afrikaans dialect. Subjects were usually keen to participate in the play and it was apparent that children in the playrooms looked upon it as a special activity.

### 2.2.2. Spontaneous Play

Materials for each task were kept in separate containers, out of the subject's view. At the outset of each task, objects were made available in scrambled order, with the comment, "Look what I've got for you to play with." Two minutes of spontaneous play followed. The period was timed from the subject's first contact with an object. No selective feedback was given though the experimenter was encouraging and responsive. If the subject handed the experimenter or the escorting adult an object, she accepted it and then replaced it on the table. If an object was dropped, it was replaced on the table. If, however, an object fell on the table while the subject was constructing something, the experimenter did not intervene. After two minutes the subject was encouraged to assist in packing the objects into the container, unless he was finishing a construction, in which case he was allowed to complete it, though constructions done in additional time are not included in the analysis. If the subject indicated that he had finished before the two minutes were over, he was encouraged to do something more with them (e.g. "What else can you play?"). Some subjects refused to continue and were permitted to pack away.

Following Sugarman (1982a and b, 1983), two tasks designed to elicit specific grouping procedures were administered twice to each subject after Tasks II and IV.

### 2.2.3. Elicitation Tasks

#### 2.2.3.1. Elicited grouping task

This was designed to prompt sorting into separate groups while shifting between classes. After the spontaneous play phase of the task, the experimenter gathered the objects and placed one example of each group 10 cm apart. She then handed the subject the rest of the objects, one by one in scrambled order (abbaba), asking "Where does that one go?" Each successive object was handed only when the previous one had been placed. If the subject did not place the object immediately, the experimenter indicated the objects on the table and repeated the question. If the subject still did not respond, she held the next object in the air, out of his reach. If this too failed, the experimenter took the object from the subject and placed it above and between the two groups.

Subjects were not allowed to move the original examples of the classes while the other six objects were presented. No feedback was given for placements made. After all the objects had been given, the subject was allowed to manipulate the array.

If the subject failed to sort into a class-consistent grouping in mixed order, a second trial followed in which the experimenter corrected misplaced objects, drawing the subject's attention to where they went. A third uncorrected trial followed.

### 2.2.3.2. Misplacement task

The experimenter presented a partially grouped array with one object from each class misplaced with three of the other class. She asked the subject "Can you fix it up?" and gave him or her one minute to do so. If they seemed at a loss, they were further prompted by the words "Put them where they should go." The target response from which simultaneous consideration of two classes could be inferred was simple reversal of the misplaced objects without resorting all objects.

## 2.3. ANALYSIS

### 2.3.1. Coding and Scoring

The coding and scoring system follows Sugarman (1983) unless otherwise indicated. Its objective is to identify not only the groupings that subjects produce but also the method of production.

In spontaneous play, children engage in a continuous stream of behaviour and this needed to be divided into discrete constructions. This was done in three steps:

- (1) A move-by-move record of subjects' manipulations of objects was transcribed from videotape.
- (2) Individual constructions and the moves leading up to them were isolated from this record.
- (3) Constructions and the method of

their production were scored for class properties.

The elicitation tasks were scored directly from videotape.

Transcription:

The data was first transcribed into sequential action units. These began with touching or manipulating an object and ended when:

- (1) the object was released;
- (2) the object was in contact with another surface;
- (3) the subject contacted another object.

Next to this record, the transcriber drew figures of the constructions as they developed and were changed by the addition, removal or re-arrangement of objects. These diagrams formed the basis from which the discrete spatial groupings (constructions) were coded and scored. The transcription also supplied a record of the order in which objects were manipulated, used to code and score sequential touching.

Criteria for a Construction:

The minimal criterion for a construction was either

- (1) spatial contact or close proximity of two or more objects, or
- (2) a loose configuration of spatially discrete subunits, e.g. two subunits of blocks on plates with other objects scattered.

A new construction began with re-arrangement of an old construction, or if a new object was added to an old construction after an object had been deleted from it (example in Appendix C). This therefore excluded immediate reconstructions of previous constructions if only one object was removed and then replaced in the same position.

#### Scoring:

Each construction was scored once at its peak and so was the procedure leading to it. Constructions in the subject's hand were scored provided that they were composed of sequential choices and were not merely a handful of objects picked up together.

Specific coding categories will be given in the relevant sections of Chapter 3.

#### Inter-rater Reliability:

A trained second rater independently went over the transcripts of four subjects, one in each age group, on all tasks and divided the recorded manipulations into constructions. Specification of the same set of objects as belonging to a particular construction constituted agreement. Inter-rater agreement was 87,8% or 36 of the 41 constructions scored by either or both the raters. Differences related to queries about when constructions were at their peak. Once the units of analysis were demarcated, specific codes were applied. Reliability in this instance was 92,6% or 38 of the 41 constructions scored.

### 2.3.2. Choice of Statistical Tests

The data for the most part takes the form of frequencies of each type of response, arranged in ordered but not continuous categories. With such nominal and ordinal data, normality cannot be assumed and it was consequently necessary to use non-parametric tests (Siegel, 1956). Previous studies in this area, using a similar approach, have used non-parametric techniques (Denney, 1972; Nelson, 1973; Ricciuti, 1965), or a combination of parametric and non-parametric tests (Starkey, 1981; Sugarman 1982a and b, 1983).

In the present study, because of the relatively small number of subjects and the small range of responses on certain tasks, non-parametric tests were applied, even in the few cases where some, though not all, of the assumptions of the more powerful parametric tests might have been met. Though this represents a departure from Sugarman's work (1982a and b, 1983), she presents no justification for the use of parametric tests.

The sample size was large enough to be well within the range dealt with by the tests used which increases their power.

The following techniques were used:

- Spearman's rank order correlation  
(formula corrected for tie scores);
- Chi-square for independent samples;
- Fischer exact probability test for  
independent samples;
- Kruskal-Wallis one-way analysis of

- variance by ranks (formula corrected for tie scores);
- Friedman's two-way analysis of variance for related samples;
- Wilcoxon matched-pairs signed ranks test for two related samples.

These were all computed in accordance with Siegel (1956).

Despite the use of non-parametric measures, much of the data does not lend itself to tests of significance without the loss of a great deal of information. Specific limitations were:

- (1) The Chi-square test requires an expected frequency of at least five in 80% of cells which, in a sample of this size, necessitates collapsing categories to raise the cell frequencies.
- (2) The Fischer exact probability test can be used with small independent samples to determine whether they differ in the proportion with which they fall into two mutually exclusive categories. This too will necessitate combining categories where there are more than two.
- (3) The non-parametric Friedman two-way analysis of variance does not give a measure of interaction.

Because of this, in certain cases, particularly in the preliminary analyses, tests of significance have been excluded and data has been presented descriptively in percentage form.

In the central portion of the results, both descriptive statistics and tests of significance have been included.

Statistical values have been computed on actual frequencies only for Part One. For values obtained for task effects

(Part Two), raw data was converted to percentages before ranking. Following other studies of early grouping behaviour, the level of significance was set at five percent.

### 3. RESULTS

#### 3.1. PART ONE: AGE EFFECTS ON GROUPING BEHAVIOUR

##### 3.1.1. Sequential Ordering

Summary Sequential Ordering

##### 3.1.2. Spatial Constructions - Unidimensional Grouping Criteria

###### 3.1.2.1. Preliminary analyses

###### 3.1.2.1.1. Base rate

###### 3.1.2.1.2. Sex-related effects

###### 3.1.2.1.3. Construction size

###### 3.1.2.1.4. Class-consistent constructions

(a) Types of consistent construction

(b) Overall consistency

(c) Size/consistency relations

(d) Consistent organisation of two classes

Summary Preliminary Analyses

###### 3.1.2.2. Classes

###### 3.1.2.2.1. Products

(a) Frequency of class grouping

(b) Most exhaustive class grouping

## 3.1.2.2.2. Class grouping procedure

- (a) Spontaneous condition
  - (i) Baseline data
  - (ii) Handling two classes in mixed or unmixed order
- (b) Elicited condition
  - (i) Elicited grouping task
  - (ii) Misplacement task
- (c) Comparison of elicitation tasks and spontaneous performance

## Summary Classes

## 3.1.2.3. Between-class correspondence

## 3.1.2.3.1. Products

- (a) Precise and imprecise correspondences
- (b) Number of subunits

## 3.1.2.3.2. Correspondence grouping procedure

## Summary Between-class Correspondence

## 3.1.2.4. Between-class symmetry

## 3.1.2.4.1. Products

## 3.1.2.4.2. Symmetrical grouping procedure

## Summary Between-class Symmetry

## 3.1.2.5. Comparison of the three types of consistent construction

## 3.1.2.5.1. Products: Inclusiveness of constructions

## 3.1.2.5.2. Grouping procedure

## Summary Comparison of Types of Consistent Construction

### 3.1.3. Spatial Constructions - Bidimensional

#### 3.1.3.1. Products

3.1.3.1.1. Number of bidimensionally consistent subclasses

3.1.3.1.2. Most consistent construction with four subclasses

#### 3.1.3.2. Grouping procedure

#### 3.1.3.3. Comparison of bidimensional and unidimensional constructions

#### Summary Bidimensional Constructions

### 3.1.4. Verbal Expressions of Class Relations

#### Summary Verbal Expressions of Class Relations

## 3.2. PART TWO: EFFECTS OF TASK CHARACTERISTICS ON OBJECT GROUPING BEHAVIOUR

### 3.2.1. Preliminary Analyses

3.2.1.1. Time used on each task

3.2.1.2. Salience

### 3.2.2. Task Effects on Sequential Ordering of Classes

### 3.2.3. Task Effects on Spatial Constructions

#### 3.2.3.1. Products

3.2.3.1.1. Base rate

3.2.3.1.2. Task and type of grouping

3.2.3.1.3. Task effects on consistency of constructions

3.2.3.1.4. Task effects on constructions at different ages

#### 3.2.3.2. Grouping procedure

#### Summary Task Effects on Object Grouping Behaviour

### 3. RESULTS

As there were several measures of the dependent variable (grouping behaviour), this section will give the following information separately for each measure:

- (1) coding categories and scoring procedure;
- (2) hypotheses and findings;
- (3) a brief consideration of the findings in the context of previous studies.

Overall points of comparison and interest will be discussed in Chapter 4.

#### 3.1. PART ONE: AGE EFFECTS ON GROUPING BEHAVIOUR

##### 3.1.1. Sequential Ordering

Sequential touching or manipulating of like objects was used as a measure of "temporal grouping" (Ricciuti, 1965; Starkey, 1981).

##### Coding:

Each subject's longest ordering sequence across all tasks (i.e. best performance) was coded from the transcriptions according to the following categories (following Starkey's (1981) modification of Ricciuti, 1965):

- Level 1 All 4 of one kind of object followed by all 4 of the other touched in sequence.
- Level 2 All 4 of one kind and 3 of the other, or 3 of one kind and 3 of the other touched in sequence.

Level 3 All 4 of one kind of object touched in sequence.

Level 4 3 of one kind touched in sequence.

Hypothesis and findings:

Table 2: Number of Subjects in Each Response Category for Sequential Ordering

Group	A	B	C	D
	16-24m	25-30m	31-36m	37-42m
N.	8	8	8	7
Level 1	1	3	4	7
Level 2	2	2	2	0
Level 3	4	3	2	0
Level 4	1	0	0	0

It was hypothesised that more subjects in Groups C and D would have Levels 1 and 2 as their highest level of sequential ordering than subjects in Groups A and B. The results (summarised in Table 2) indicate a shift from one-class sequential orderings to two-class orderings. Some subjects at each age selected from both classes, but this increased from only 37,5% of Group A to an exhaustive selection from both classes by all of Group D. Fischer Exact Tests were computed to test for differences between age groups. There was a significant difference in level of grouping between Groups A and D ( $p < .05$ ), but differences between the other groups were not significant. There was a significant correlation between age and the longest ordering sequence for each subject ( $r_s = .6025, p < .01$ ).

Comparison with previous studies:

Mean ages per group in this study are slightly higher than those in Sugarman (1982b) but the results are comparable. At 18,9 months (Group A), three of eight subjects grouped from both classes (Sugarman, 18 months, five of eight), at 26,5 months (Group B), five of eight (Sugarman, 24 months, seven of eight), at 32,3 months (Group C), six of eight (Sugarman, 30 months, seven of eight) and by 39,9 months (Group D), all subjects grouped exhaustively from both classes (Sugarman by 36 months). The shift from one- to two-class orderings is consistent too with Ricciuti (1965).

This analysis of extended ordering sequences indicates the decrease of salience as the basis for grouping. Firstly, choice of several objects from one class in succession rather than sequential manipulation of, say, two items of that class, e.g. 01 then 02 then 01, suggests that something more than salience is operating. This suggestion is further supported by the context of increasing manipulation of objects of both classes by older children.

Summary Sequential Ordering

The main result of the analysis of sequential ordering was:

- (1) The trend for older children to sequentially order both classes was significant for Group D compared with Group A ( $p < .05$ ).

### 3.1.2. Spatial Constructions - Unidimensional Grouping Criteria

The analyses in this and all following sections are based on the combined data from Tasks I, II, III, IV and V, except when otherwise indicated. Task VI (blue and red balls) has been excluded from the analysis because although pilot runs had indicated that it would elicit grouping behaviour, in practice many subjects engaged in a great deal of manipulative behaviour which involved handling several items simultaneously. This made the transcribed behaviours ambiguous and it was therefore excluded.

#### 3.1.2.1. Preliminary analyses

Various preliminary analyses were necessary as they have a bearing on the interpretation of the results of subsequent analyses.

##### 3.1.2.1.1. Base rate

It was necessary to determine whether subjects at different ages produced different numbers of constructions as this could be a confounding factor in interpretation of the results. For example, if older subjects produced more constructions than younger subjects, they would have more opportunity to display more complex groupings and a chance behaviour might consequently emerge as an age-related trend.

A total of 435 constructions was scored with a mean occurrence of 14,1 constructions per subject (means for the respective age groups - 13, 14,5, 12,3, 16,7). The number of constructions did not vary significantly with age (Kruskal-Wallis one-way anova:  $H = 2,95$ ,  $df 29, p > .3$ ).

This indicates that variations in the base rate (total constructions) are due to random sampling variation. Therefore, trends that emerge in the data are not artefacts of a changing base rate.

As there were no significant differences in the number of constructions per age group, the total number of constructions is considered to be equal when computing age comparisons of different levels of grouping behaviour.

#### 3.1.2.1.2. Sex-related effects

Although it was not possible to counterbalance completely for sex within age groups, no significant overall sex effects were found on total constructions ( $t = .2108$ ,  $df 29$ ) or on the number of consistent constructions ( $t = .1438$ ,  $df 29$ ).

#### 3.1.2.1.3. Construction size

With age, increasing numbers of objects were incorporated in the constructions.

Table 3 summarises the percentage of constructions falling within different size ranges at each age.

Table 3: Number of Constructions in Different Size Ranges  
for Each Age Group

Group	A	B	C	D
	16-23m	24-30m	31-36m	37-42m
No. of Objects per Construction				
2-3	76 (73)	60 (52)	33 (34)	29 (25)
4-5	20 (19)	26 (22)	27 (27)	31 (26)
6-8	8 (8)	30 (26)	38 (39)	57 (49)
Mean No. Constructions per Subject	13	14,5	12,3	16,7

Note: Percentage of total constructions is indicated in brackets.

Older subjects used all eight objects more often in a construction than younger subjects. Group A included 2,9 objects in their constructions on average, but by 37-42 months (Group D), nearly six was common. The mean number of objects per construction per subject was 2,9, 3,9, 5,0 and 5,5 for Groups A, B, C and D respectively.

Comparison with previous studies:

This is the same trend found in the Sugarman study (1983) and the increase relates to an increase in larger constructions (6-8 objects) from 8% for Group A to 49% for Group D. In both studies the middle-sized constructions remained relatively constant.

A difference that should be noted is that the 18-month old subjects in this study more closely match the performance of the 12-month olds in the Sugarman group, five of whom did not group six or more objects. Six of eight in

Group B, seven of eight in Group C and all of Group D used eight objects in at least one construction.

#### 3.1.2.1.4. Class-consistent constructions

This section of the study was concerned with simple additive classification, that is, groupings based on one possible criterion. On the task with convergent criteria (Task II - colour and form), classification by form was far more common, a trend found in many other studies (e.g. Brian and Goodenough, 1929; Casey, 1979; Descourdres, 1914 cited by Sugarman, 1983, p. 11; Sugarman, 1983). Only one subject clearly grouped colour independently of form though there was colour/form vacillation by some subjects. As many groupings are ambiguous as to whether form or colour was the criterion for the construction, it was necessary to select one as a basis for coding constructions and form was the obvious choice.

#### (a) Types of consistent construction

In categorising constructions, Sugarman's (1982b) "weak" definition of class groupings was followed rather than the more stringent criteria employed by Ricciuti (1965) and other researchers which require the inclusion of almost all test objects. As the focus of this study was on changes in the actual grouping procedures, it became important to broaden the data base in this way so that changes could be measured. Sugarman (1982a) points out that the inclusion of partial groupings which have been

shown to be typical of the grouping patterns of younger children (Kofsky, 1966; Inhelder and Piaget, 1964; Ricciuti, 1965; Starkey, 1981) would increase the likelihood that younger children could produce structures in the more advanced mixed order way. In other words, it biases the analysis against the expected trend by providing opportunities for younger subjects to show more advanced behaviour.

The specific focus of this study is on class-consistent constructions and three types were identified:

(1) Classes

These are spatial constructions put together on the basis of a common attribute.

(2) Between-class correspondence

A construction in which elements from one class are arranged in the same way in relation to elements of the other. Here spatial contiguity exists between elements from different classes but there is ordering of objects by a constant relation, e.g. containment (a block on a plate); dissimilarity (a triangle and a hexagon); or function (animal and furniture).

(3) Symmetry

In these arrangements, elements from the same class are placed symmetrically relative to a central point. Here too objects are ordered by a constant relation.

Table 4: Types of Construction by Age

	Total	Correlation	Symmetry	1-Class	Transitional	2-Class	Mixed
Group A	104	-	-	72	-	9	23
Group B	116	11	5	63	3	15	19
Group C	98	13	5	50	1	20	9
Group D	117	11	2	42	6	32	24

Table 4 gives the frequencies of each type of construction for the different age groups. These will be commented on in the detailed analyses of each type below.

(b) Overall consistency

In this analysis, those constructions which conform to the three types defined above are separated from the total which included mixed constructions - conglomerates in which no pattern is discernible.

Differences in total number of consistent constructions at different ages were tested with a Kruskal-Wallis one-way analysis of variance and did not reach significance

( $H = 2,78$ ,  $df 3$ ,  $p > .3$ ). Group totals were 81 (77,8%), 97 (83,6%), 89 (91%) and 93 (79%) for Groups A, B, C and D respectively,

Comparison with previous studies:

This result differs from Sugarman (1983) who found a steady and significant increase from a mean percentage of 49 to 55, 68 and 66% at 18, 24, 30 and 36 months respectively. This is accounted for by the relatively high proportion of one-class constructions produced at all ages in this study.

(c) Size/consistency relations

Size/consistency relations are of interest because it has been commonly found that the consistent constructions of younger children are more likely to be non-exhaustive (e.g. Ricciuti, 1965; Sugarman, 1983).

Table 5: Number of Consistent Constructions by Size and Age

Group	A 16-23m	B 24-30m	C 31-36m	D 37-42
No. Consistent Constructions				
2 - 4 Objects	76 (80,9%)	73 (83,9%)	56 (94,9%)	50 (87,7%)
Mean per Subject	9,5	9,125	7,0	7,14
5 - 8 Objects	5 (50%)	24 (82,7%)	33 (84,6%)	43 (71,6%)
Mean per Subject	0,625	3,0	4,125	6,14
Total	81 (77,8%)	97 (83,6%)	89 (91%)	93 (79%)
Mean per Subject	10,125	12,125	11,125	13,28

Note: Percentage of consistent constructions in each size range is given in brackets.

Table 5 indicates a steady increase in the number of consistent constructions with five to eight objects from Groups A to C. Group D produced the most larger-sized constructions but only 71,6% of these were consistent. Read in conjunction with Table 3, this indicates that there is a tendency for increasing size to indicate increasing consistency but that these do not completely overlap.

Comparison with previous studies:

The proportionate increase in larger consistent structures was also found by Sugarman (1983). However, she found a corresponding decrease in the consistency of two-to four-object constructions in subjects over 30 months. In the present study, results indicate that consistency of the smaller constructions always outweighs that of the larger ones.

(d) Consistent organisation of two classes

Constructions with five to eight objects always contain two classes, but with the weak definition of a class, so could a four-object construction. This analysis therefore includes those two-to four-object constructions which contain two classes.

The number of all consistent constructions with two classes increased from 9 (11,1%) to 31 (31,9%), 38 (42,7%) and 45 (48,4%) in Groups A, B, C and D respectively. A Kruskal-Wallis one-way analysis of variance was computed and found these differences to be significant ( $H = 11,46$ ,  $df 3$ ,  $p < .01$ ).

Comparison with previous studies:

These percentages are lower than those in Sugarman's study (47, 67, 85 and 77% at comparable ages). Whether this reflects task differences or a possible developmental lag will be considered below. However, the types of grouping were on the whole similar in both studies, despite different materials.

### Summary Preliminary Analyses

Thus far, the results of these preliminary analyses indicate:

- (1) A base rate which does not vary significantly with age.
- (2) No sex-related effects on total constructions or percentage of consistent constructions.
- (3) Increasing numbers of objects used in constructions as a function of increasing age.
- (4) No differences in the total number of consistent constructions (class construction, between-class correspondence, symmetry) related to age.
- (5) A tendency for increasing consistency of constructions of all sizes from Group A to Group C.
- (6) A significant increase in consistent constructions with two classes in relation to age.

In the subsequent sections, each type of consistent construction will be analysed in detail.

#### 3.1.2.2. Classes

##### 3.1.2.2.1. Products

##### Coding and scoring:

A construction was defined as a class if:

- (1) all the objects in it were uninterrupted by objects from the other class, and
- (2) at least two examples of the class were included.

This includes partial groupings, e.g. AA or AAB are one-class constructions. A two-class construction is any

combination in which at least two As and Bs are both included and not interspersed, e.g. AABB or AAABBBB. In this study, the AAB definition of a two-class construction (Sugarman, 1983) is considered to be too weak to exclude random placement.

Transitional constructions: A few subjects produced constructions with four of each class but one discordant element, e.g. AAABBBBA. These do not conform with the requirements that elements from both classes are not interspersed. They do, however, indicate an intention to group not completed in performance. Following studies of conservers and non-conservers (cf. Flavell and Wohlwill, 1969; Modgil and Modgil, 1976; Piaget, 1974 in Gruber and Voneche, 1977, p. 356), a transitional category ranked between one- and two-class constructions was included to account for these. For purposes of comparison with Sugarman, transitional groupings will be coded as one-class constructions.

Mixed constructions: These had elements from both classes interspersed, e.g. ABABB. However, if all the items from one class were grouped together, they would still be considered as a one-class construction, e.g. AABBBBA.

To summarise, classes were coded as follows:

One-class: at least two items uninterrupted by other class.

Transitional: all four of each class but one misplacement.

Two-class: at least two items of each class uninterrupted by member of the other.

Mixed: items from both classes interspersed.

Hypothesis and findings:

It was expected that there would be an increase in the frequency of two-class constructions specifically, that Groups C and D would show more two-class constructions than Groups A and B.

(a) Frequency of class groupings

Each subject grouped same-class objects and the frequency did not vary significantly with age ( $H = 1,63$ ,  $df 3$ ,  $p > .5$ ). The mean percentage of class constructions (one- and two-class) was 77,9%, 69,8%, 72,4% and 68,4% for Groups A, B, C and D respectively. Scored on Sugarman's "weak" criteria, 25 subjects produced at least one two-class construction (four of the subjects who only grouped by one class were in Group A and the other two were in Group C).

The mean percentages of two-class constructions were 11,1, 18,5, 28,1 and 40%. A Kruskal-Wallis one-way analysis of variance indicated that the difference between age groups was not significant ( $H = 7,43$ ,  $df 3$ ,  $p < .1$ ). However, a trend can be discerned.

Transitional constructions formed a small proportion of all constructions. Eight subjects produced them and each of them also produced at least one two-class construction which indicates that transitional is a valid category. However, as the numbers were so small, it was not used in any of the general analyses (and was incorporated into the one-class category).

Comparison with previous studies:

The proportion of two-class constructions was lower than Sugarman (1983) who had 33, 53, 70 and 66% at 18, 24, 30 and 36 months respectively. Results in the present study do, however, indicate a similar age-related increase.

(b) Most exhaustive class grouping

This analysis refers to the most complete class construction produced by each subject, i.e. the best performance over all his tasks.

Coding and scoring:

This was based on Ricciuti's (1965) categories:

- Level 1 Four of each kind displaced from original location and constituted as spatially separate groups.
- Level 2 Incomplete or partially correct groups, constituted and spatially separated (at least three of one kind in each group).
- Level 3 All four of one kind constituted as a group and spatially separated.
- Level 4 Three of one kind.

Hypothesis and findings:

It was expected that the exhaustiveness of constructions would increase in relation to age. Specifically, it was hypothesised that Groups C and D would group more exhaustively than Groups A and B.

Table 6: Number of Subjects in Each Response Category for Most Exhaustive Grouping

	A	B	C	D
Group	16-23m	24-30m	31-36m	37-42m
Level 1	2	2	4	5
Level 2	1	2	1	2
Level 3	3	2	3	-
Level 4	2	2	-	-

As Table 6 indicates, there was a steady trend with age from one-class constructions to increasing two-class constructions.

A Chi-squared test of the relative frequency of one- and two-class constructions for Groups A and B combined versus Groups C and D was significant ( $\chi^2 = 4,29$ ,  $df\ 1$ ,  $p < .05$ ), allowing acceptance of the hypothesis.

There was a significant positive correlation between age and most exhaustive grouping ( $r_s = .568$ ,  $p < .01$ ).

Comparison with previous studies:

This trend closely follows Sugarman's findings (1982a) where 25%, 87,5%, 62,5% and 87,5% of her subjects at 18, 24, 30 and 36 months grouped two classes as their highest level of performance. The results of the present study do, however, include a greater number of Level 2 groupings. In Sugarman only two 24-month olds grouped at Level 2.

A comparison with Ricciuti (1965) shows the same trends for Groups A and B though there is a greater frequency of one-class constructions than in his best task. All subjects

achieve at least Level 4 at 16-23 months in the present study whereas only 53% of his subjects did. At the 24-30 month age level, all subjects in this study achieved at least Level 4 grouping, while only 67% of Ricciuti's subjects did. However, the percentage of exhaustive groupings on his best task (his results do not give the relative proportion of Level 2 groupings) was somewhat higher than this study: 35% at 18 months (present study 25%) and 33% at 24 months (present study 25%). This comparison does not, however, take into account task characteristics.

#### 3.1.2.2.2. Class grouping procedure

##### (a) Spontaneous condition

This measure of the manual procedure for arranging objects into classes was critical for the attempt to establish whether or not there was a shift between what older and younger children consider when grouping classes.

##### Coding and scoring:

There are three possibilities in constructing classes:

- (1) items from only one class in the construction;
- (2) items from two classes placed one class at a time;
- (3) items from two classes placed in mixed order into a consistent arrangement.

The inference from procedure 3 is that sorting in mixed order requires the ability to consider both groups simultaneously and indicates a co-ordination of concepts.

Hypothesis and findings:

It was expected that level of best spontaneous grouping procedure would be positively correlated with age.

(i) Baseline data:

Firstly, the data was analysed to establish whether the increase with age of two-class constructions was related to increased handling of two classes. That is, that a two-class construction was composed by directly manipulating both classes, for example, animals and furniture, which suggests that both classes have been considered, or alternatively, a group of animals was added to an already established group of furniture. In the second case it is more likely that only one class was considered.

The proportion of two-class constructions produced by handling both classes was relatively constant with age - 77%, 86%, 60% and 62,5%. Furthermore, this trend closely related to the proportion of mixed classes produced by handling two classes - 78%, 79%, 62,5% and 65%.

Comparison with previous studies:

Sugarman (1983) found that her younger subjects produced very few two-class consistent constructions by direct manipulation of both, though this changed at higher ages, indicating that younger subjects were more likely to achieve consistency when working with one class at a time. The differences were, however, most pronounced under 24 months and it is possible that the low number of two-class constructions in Group A in this study might account for

this difference.

(ii) Handling two classes in mixed or unmixed order:

Table 7: Number of Subjects in Each Response Category for Spontaneous Grouping Procedure

Group	A	B	C	D
	16-23m	24-30m	31-36m	37-42m
One class	4	-	2	1
Two classes grouped successively	3	7	5	5
Two classes grouped in mixed order	1	1	1	1

Table 7 is based on each subject's most advanced grouping procedure and summarises the response categories per age group. As can be seen, only four subjects aged 23, 27, 31 and 41 months engaged in the mixed order grouping. Each of these also grouped successively. No subject used the mixed order grouping procedure more than twice. As there are three response categories, Chi-square and Fischer exact probability tests for differences were not appropriate, however a Spearman's rank order correlation of age with best spontaneous grouping procedure indicates that contrary to expectations, the relationship between these variables was not significant ( $r_s = .2766, p > .05$ ).

Comparison with previous studies:

Sugarman (1983) found that one-third of her subjects from 24 months grouped two classes in mixed order. She found a significant increase in the proportion of constructions

produced in mixed order as well as the number of subjects using this method per age. It is, however, worth noting that none of her subjects used the method more than three times, although the percentage of two-class constructions is far greater than that in this study.

(b) Elicited condition

The procedure described in the previous section takes account of spontaneous grouping. This section gives the results of two tasks which were designed to push subjects to use the more complex mixed order grouping - elicited grouping task - and to test for simultaneous consideration of classes in a different kind of task - misplacement task.

The elicited tasks were scored directly from the videotape. Both tasks were administered twice and the subject was credited with the better of his two performances on each.

(i) Elicited grouping task:

Coding and scoring:

As this task was concerned with the order of grouping, it was only scored after all objects had been placed. This score was a measure of the subjects' best possible performance and scores improved by the feedback trials are included.

Categories were as follows:

- 0 No grouping (includes heterogeneous groupings)
- 1 Groups one class
- 2 Groups two classes one at a time
- 3 Groups two classes in mixed order.

These were applied except in the case of between-class correspondence. In this case, subjects were credited 1 for producing scattered subunits, 2 for composing and then integrating subunits and 3 for varied composing and integrating. These categories are derived from grouping procedure for between-class correspondence. This departure from Sugarman (1983) was necessary as she did not report any correspondence on the elicitation tasks.

Hypothesis and findings:

It was hypothesised that there would be a positive correlation between age and level of grouping procedure on the elicited grouping task.

As only the better of each subject's performances is included in the analysis, only two scores based on feedback trials are included below.

Table 8: Number of Subjects in Each Response Category for Elicited Grouping Task

	A	B	C	D
Group	16-23m	24-30m	31-36m	37-42m
Grouping Procedure				
No grouping	4	4	-	-
1 Class	-	-	-	-
2 Class one at a time	3	-	-	-
2 Class in mixed order	1 (1)	4 (1)	8	7

Note: The brackets indicate the number of scores improved by feedback trials.

Table 8 indicates that subjects in Groups C and D used more

sophisticated procedures than subjects in Groups A and B. Although the number of categories precluded an analysis of group differences using either Chi-square or Fischer's exact probability test, the strongly significant correlation of age with level of response ( $r_s = .713, p < .01$ ) confirms the hypothesis. Consistency on both trials was age-related. Half of Group A failed to group on either and five of the seven subjects in Group D succeeded on both.

These results also indicate a significant improvement over the level of spontaneous performance, particularly for Groups C and D ( $\chi^2 = 9.76, df 2, p < .01$ ). Five subjects in Group B and all subjects in Groups C and D grouped in mixed order on at least one trial. This represents an improvement in performance of 13 subjects in Groups C and D, three of whom had only grouped single classes in the spontaneous tasks. Half of Group B improved their level of grouping in the elicited condition.

Although there was such a high percentage improvement over spontaneous performance, seven subjects under 30 months responded at a lower level on this task. Although they had spontaneously produced one- (three subjects) and successive two-class (four subjects) constructions, they placed objects randomly.

These younger subjects appeared to find it difficult to extract the meaning of the experimenter's game during the elicited grouping task. They kept trying to move the example blocks during the presentation, and seemed to

extract only a handing over and placing scheme rather than reading the grouping cues provided by the examples. In addition, three subjects produced a correspondence on the block/plate task which indicates a stronger prior scheme elicited by the materials. The older subjects, on the other hand, who were more secure in their two-class groupings, found themselves able to extract these rules.

Of the younger subjects who persisted in successive grouping, two re-grouped after the presentation and one held items from one class in her hand, refusing to place them.

Comparison with previous studies:

The strategies used to avoid mixed order grouping in this study and the age-related trend toward consistency on both elicited grouping tasks were noted too by Sugarman (1983). However, she found that performance on the elicited grouping task replicated spontaneous performance. This represents a major difference. Why a number of subjects in this study who clearly had this ability did not manifest it spontaneously will be considered in Chapter 4.

(ii) Misplacement task:

This provided another measure of the simultaneous consideration of classes. Subjects were presented with a partly grouped array with two misplaced objects and required to "Fix it up".

Coding and scoring:

Responses to the task were coded as follows:

- 0 No correction (at least two objects from each class misplaced)
- 1 One class corrected
- 2 Two classes corrected by moving multiple objects
- 3 Two classes corrected by moving only misplaced objects.

Hypothesis and findings:

Table 9: Number of Subjects in Each Response Category for Misplacement Task

Group	A	B	C	D
	16-23m	24-30m	31-36m	37-42m
No Response	1	-	2	-
No Correction	3	4	3	1
One Class Corrected	2	2	1	2
Two Classes Corrected by Moving Multiple Objects	2	2	2	3
Two Classes Corrected by Reversal	-	-	-	1

It was expected that there would be a positive correlation between age and level of correction on the misplacement task. Table 9 indicates that some subjects at each age re-grouped all the objects successively, and some corrected one class by reversal. Only one child aged 37 months corrected two classes by reversal. The number of categories precluded the use of Fischer's exact probability test or

Chi-squared (n. too small) but the correlation of age and best level of correction ( $r_s = .303, p > .05$ ) was not significant and the hypothesis was not confirmed.

No child succeeded on both trials, only two subjects over 37 months maintained their performance (at Level 2) though 13 subjects consistently failed both.

It appeared that many subjects were unable to interpret the cues in the arrangement of the array. Roughly half the subjects under 36 months either failed to respond or first looked quizzically at the experimenter, then, after hearing the instruction again, joined the two groups, aligned the items, or moved one or two. On the block/plate probe, five children imposed a between-class correspondence on the items. Nor did additional verbal cues such as "What goes with what?" or "Maak hulle dieselfde" elicit a more appropriate response.

#### Comparison with previous studies:

The results are strikingly different from Sugarman (1983). She found that over half her subjects at 30 and 36 months reversed the misplaced objects.

#### (c) Comparison of elicitation tasks and spontaneous performance

This section analyses how consistent each subject's performance was on the different measures.

Table 10: Class Grouping Measures on which Subjects  
Achieved Co-ordination of Classes

Group	A	B	C	D
	16-23m	24-30m	31-36m	37-42m
Spontaneous mixed order	1	1	1	1
Elicited grouping	1	5	8	7
Misplacement correction	-	-	-	1

Table 10 summarises the number of subjects in each age range who achieved co-ordination of classes on the three measures. As so few subjects achieved co-ordination of classes spontaneously or on the Misplacement Task, the results are presented descriptively with no statistical analysis.

All four who achieved mixed order grouping spontaneously achieved it on the elicited grouping task as well.

However, 59,25% (16/27) of those who did not spontaneously co-ordinate classes did so on the elicitation task. As so few subjects achieved mixed order grouping spontaneously, it is difficult to draw conclusions about a possible carry-over effect from the elicited tasks into spontaneous behaviour. Two of the four subjects who grouped in mixed order did so after the elicited tasks (aged 23 and 27 months) and two over 30 months exhibited it before the tasks.

### Summary Classes

The main findings in this section can be summarised as follows:

- (1) Overall frequency of class constructions (one- and two-class) did not vary significantly in relation to age.
- (2) There was an increasing trend towards two-class constructions with increasing age.
- (3) Level of spontaneous grouping procedure did not vary significantly with age.
- (4) Level of elicited grouping procedure was significantly related to age and was a significant improvement over subjects' spontaneous level of grouping.
- (5) There were no significant differences in level of misplacement correction for different age groups.

#### 3.1.2.3. Between-class correspondence

9,7% of class-consistent constructions (8,0% of total constructions, 28,5% of two-class constructions) produced in this study were between-class correspondences.

##### 3.1.2.3.1. Products

###### Coding and scoring:

The minimum criteria for a between-class correspondence to be credited were that

- (1) objects from one class were arranged in the same relation to objects from the other, and that the role of each served remained constant (e.g. blocks were always placed on plates);

(2) there was more than one example of this relation.

Because it was this relation that was of interest, discrete sub-constructions did not have to be integrated to be credited. Likewise, this relation manifested even in the absence of precise one-to-one correspondence and imprecise correspondences were credited (i.e. two blocks on one plate, one on another). Though this was a lower level response, it limited the number of subunits subjects could produce and was therefore reflected as a lower score.

(a) Precise and imprecise correspondences

Hypothesis and findings:

It was expected that both precise and imprecise correspondences would be produced by subjects.

Table 11: Relative Frequencies of Precise and Imprecise Correspondences per Age Group

Group	A 16-23m	B 24-30m	C 31-36m	D 37-42m
Imprecise	0	1	3	2
Total	0	11	13	11

As can be seen in Table 11, no correspondences were produced by Group A though frequencies for the Groups B, C and D were fairly consistent. This may be related to the relative size of constructions produced by Group A. Only 16% of their constructions contained four or more objects, the minimum required to produce a correspondence (compared with 44%, 65% and 77% for Groups B, C and D respectively).

17,1% of correspondences were imprecise. Only three subjects, one in Group C and two in Group D, exclusively produced imprecise correspondences.

Comparison with previous studies:

Sugarman (1983) found that her 12-month old subjects produced a negligible amount of correspondences and the absence of this form in Group A who had a mean age of roughly 18 months suggests a possible developmental lag. In both studies, subjects in all age groups who constructed correspondences produced both precise and imprecise correspondences.

(b) Number of subunits

This provided a measure of inclusiveness of grouping.

Coding and scoring:

Each subject's highest number of subunits in a correspondence was categorised.

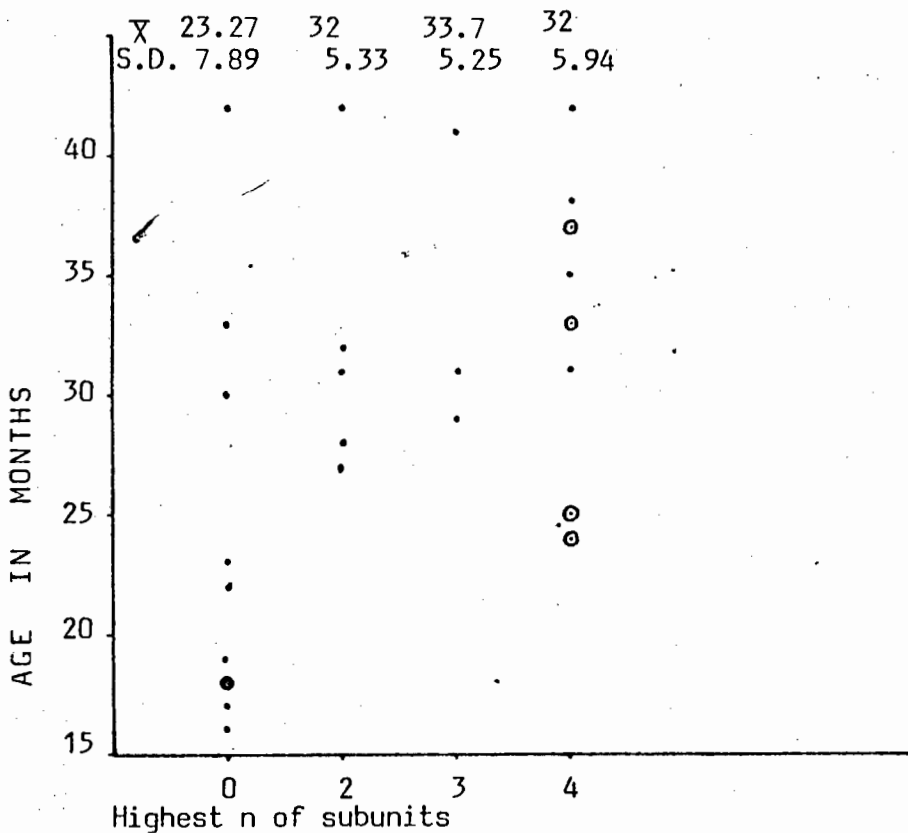
Hypothesis and findings:

A positive relationship between age and number of subunits constructed was hypothesised.

Table 12: Number of Subjects at Each Age Level Utilising Different Numbers of Subunits in their Correspondence Constructions

Group	A 16-23m	B 24-30m	C 31-36m	D 37-42m
None	8	1	1	1
2	0	2	2	1
3	0	1	1	1
4	0	4	4	4

Figure 2: Each Subject's Age in Months by Highest Number of Subunits Constructed



- ⊙ indicates 2 Ss of equal ages in same category
- indicates 3 Ss of equal ages in same category

As shown in Table 12, there appear to be no group effects on the number of subunits produced once this particular form of consistent construction appears after 25 months. Though this is frequency data, for reasons of the number of observations in each category, appropriate techniques for statistical tests of significance could not be found. A Spearman's rank order correlation of age and number of subunits was significant ( $r_s = .569, p < .01$ ) and is shown in Figure 2. An examination of the mean ages of subjects scoring in categories 0, 2, 3 and 4 were 23,27, 32, 33,7 and 32 months respectively, indicating that the difference lies in the fact that younger subjects did not produce correspondences.

Comparison with previous studies:

Sugarman (1983) found a significant age-related increase in number of subunits grouped.

3.1.2.3.2. Correspondence grouping procedure

Just as in the case of classes, different methods of constructing correspondences were distinguished.

Coding and scoring:

The categories were as follows:

- (1) No correlation responses;
  - (2) No integration of subunits;
  - (3) Subunits were composed and then integrated, or part of each subunit was integrated and then composed by adding objects from the other class (e.g. either all the block/plate subunits were brought together or, first all the plates were grouped and then the blocks added).
  - (4) The composition/integration sequence was interspersed.
- Category 3 was considered to be the equivalent of successive class grouping and 4 of co-ordinated mixed order grouping.

Hypothesis and findings:

A positive correlation between age and level of grouping procedure was expected.

Table 13: Number of Subjects in Each Response Category for Correspondence Grouping Procedure

Group	A	B	C	D
	16-23m	24-30m	31-36m	37-42m
No correspondence	8	1	1	1
No integration	-	4	3	3
Successive (a)	-	3	2	3
Co-ordinated	-	-	2	-

(a) compose then integrate/integrate then compose.

Figure 3: Each Subject's Age in Months by Highest Level of Correspondence Grouping Procedure

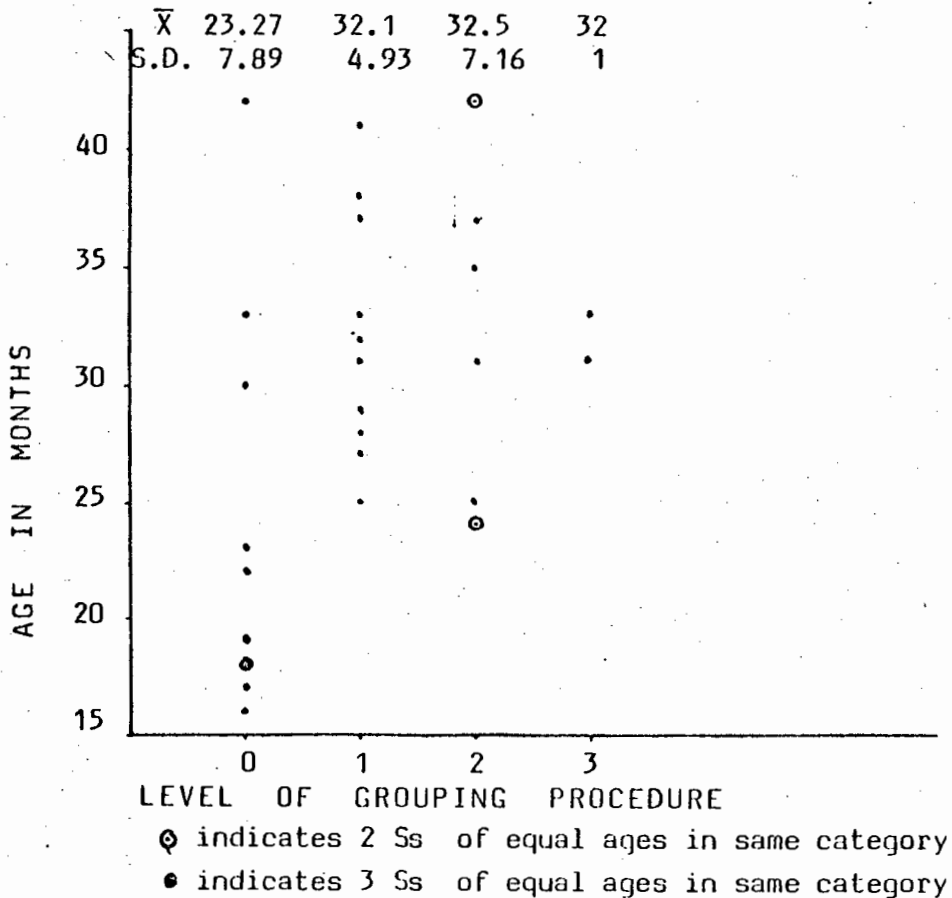


Table 13 presents each subject's best performance compared for age groups. Tests of significance of frequency data were not applied because the categories could not be meaningfully

collapsed. Figure 3 illustrates the significant correlation between age and grouping procedure ( $r_s = .491$ ,  $p < .01$ ). An examination of mean ages for categories 1, 2, 3 and 4 of 23, 27, 32, 1, 32, 5, and 32 months respectively indicates that this difference reflects the fact that the youngest subjects did not produce correspondences. There are no apparent differences once this type of construction appears. Only two subjects used a co-ordinated procedure for constructing a correspondence; one constructed a linear correspondence in which the relationship is one based on difference and extended horizontally, eg.  $\bigcirc \blacksquare \bigcirc \blacksquare \ominus \square \ominus \square$ . The other alternated between composing and integrating. Roughly 43%, 25% and 50% in Groups B, C and D respectively used procedures equivalent to successive class grouping.

#### Comparison with previous studies:

Sugarman (1983) found a significant correlation between age and level of correspondence grouping. Nine of her subjects over 30 months (24% of all subjects who produced correspondences) engaged in co-ordinated procedures.

#### Summary Between-Class Correspondence

The main findings in this section can be summarised as follows:

- (1) Group A produced no correspondences, but 87,5% of Groups B and C and 86% of Group D all produced at least one.
- (2) Age and number of subunits were significantly correlated but this statistic reflects only the fact that Group A subjects did not produce any correspondences, the other groups producing roughly equal proportions of all three.

(3) Age and grouping procedure were positively correlated but this too is a reflection of the absence of correspondences in Group A.

#### 3.1.2.4. Between-class symmetry

A few subjects produced symmetrical constructions and as these are a form of consistent construction noted in other studies of early grouping behaviour (Forman, 1982b; Inhelder and Piaget, 1964; Sugarman, 1983), they have been included for the sake of completeness.

##### 3.1.2.4.1. Products

###### Coding and Scoring:

A construction was defined as symmetrical if there was a repetition of exactly similar objects/elements facing each other or a central object.

Like between-class correspondences, they are consistent arrangements in which objects from the same class are not spatially contiguous. There were few examples of this type of grouping and all of them used all eight items. There was therefore insufficient basis for a grading into levels of complexity of symmetrical constructions.

###### Hypothesis and findings:

It was expected that some constructions of this type would be produced and symmetrical constructions were found to account for 9,75% of all constructions with two classes in this study. Seven subjects, two in Group B, three in Group C and two in Group D, constructed at least one symmetrical arrangement of objects. A third subject in

Group B produced a pattern (see Figure 4) which conforms more closely to a symmetry than to a class or correspondence, but is not strictly symmetrical.

Comparison with previous studies:

Symmetrical groupings have been noted in this age range in several other studies:

Sugarman (1983) has noted it from 30 months. Ricciuti and Johnson (1965) from 40 months and Inhelder and Piaget (1964) from about four years. Forman (1982b) has studied the origins of symmetry from the first year, but describes "reiterative" symmetry, the type discussed here, from 27 months.

3.1.2.4.2. Symmetrical grouping procedure

While this type of grouping has been widely noted, there has been little agreement about the extent to which logical or perceptual comparisons can account for it. Placement must depend upon perceptual comparison as any object can equally well be placed next to any other. If the child works from the centre out, he could successively match pairs of objects, a purely perceptual strategy. However, other methods of construction might rely on co-ordinating two interobject comparisons - a logical process.

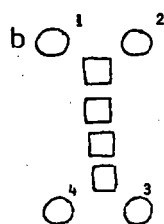
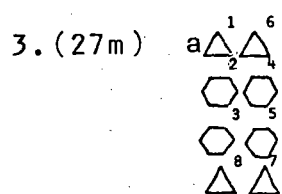
As there were few symmetrical constructions and the extent to which the grouping procedures are analogous to those used in class and correspondence construction is doubtful, the data is presented descriptively.

Hypothesis and findings:

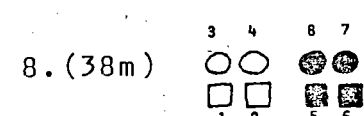
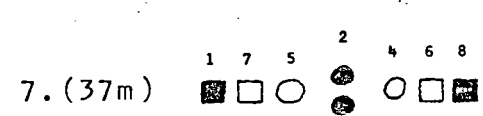
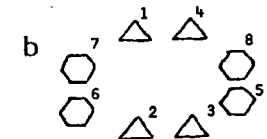
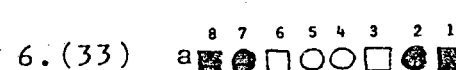
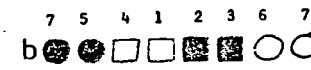
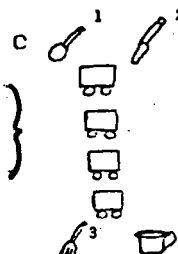
In accordance with the expectation that older children would be able to co-ordinate interobject comparisons, it was expected that certain of the symmetries produced would have been constructed on this basis.

Figure 4 illustrates all the symmetrical constructions produced in this study as an aid to the discussion of grouping procedure. The number above each object in the diagrams indicates the order in which it was placed.

Figure 4: Between-class Symmetries Produced by Subjects



not moved



Note: Superscript numbers indicate order of placement

Production of the following symmetries can be accounted for by perceptual comparisons:

Example 1 is not strictly symmetrical though the pattern is repeated. It was produced by first grouping the hexagons and then the triangles. Symmetry 2 may have proceeded by grouping like forms as the two columns were already in place. She first added the cylinders and then the remaining columns.

In 3a a triangle was placed first, followed by all the hexagons and then the remaining triangles. This could also therefore be accounted for by successive matching.

Symmetries 3b and c were constructed around the inside class by matching pairs of objects.

Symmetries 4, 5b and 6b and 7 were all constructed from the middle out by matching identical pairs of objects and placing them successively. The following constructions involved more complex procedures:

Symmetry 5a involved comparisons at both ends of the construction in placing items 3 and 4. To achieve this location of objects in the same relative placement on either side of the array would have involved more than looking for another like object.

Symmetry 8 similarly was not a product of placing like objects successively.

Symmetry 6a, which was produced linearly from right to left, is one with the strongest evidence of co-ordination as colour, form and location of each object had to be considered.

#### Comparison with previous studies:

The majority of constructions considered here as in Sugarman (1983) support Inhelder and Piaget's (1964) suggestion that symmetries are perceptually based. However, some of the constructions, both in this and Sugarman's study, could not have been produced solely on the basis of successive perceptual comparisons. Further work is needed to clarify different levels of procedure in constructing symmetries.

#### Summary Between-class Symmetry

A small percentage of symmetrical constructions (2,8% of the total number of constructions) were noted in this study. Grouping procedures were largely perceptual but certain procedures suggest a higher level of interobject comparison.

#### 3.1.2.5 Comparison of the three types of consistent construction

##### 3.1.2.5.1. Products: Inclusiveness of constructions

#### Hypothesis and findings:

It was argued in 3.1.2.1.4. that classes, between-class correspondence and symmetry are all systematically patterned according to class relations of different types. It therefore follows that one would expect consistency in the

levels of these different forms. As symmetry was difficult to quantify and represented a small proportion of total constructions, this section concentrates on individual consistency between classes and correspondences and the way they were produced.

Classes and correspondences both became more inclusive with increasing age, though this trend was more pronounced in the class constructions. Seven of those 14 who produced exhaustive two-class constructions also produced four unit correspondences. Five subjects who did not produce exhaustive two-class constructions produced 4 subunit correspondences, two of these in addition producing exhaustive symmetries.

Comparison with previous studies:

In the Sugarman (1983) study, subjects' class constructions and correspondences each became more inclusive with increasing age. 70,8% (17 of 24) of her subjects who produced exhaustive two-class constructions produced exhaustive (4 subunit) correspondences. A further two subjects produced exhaustive correspondences but no two-class constructions, using all objects. The trends in her study are therefore in the same direction as those in the present study, although consistency between forms in her study is greater.

### 3.1.2.5.2. Grouping procedure

It was also of interest to know whether there is an association between the methods used to combine objects in class constructions and between-class correspondences. The analysis is based on each subject's most advanced class and correspondence grouping procedure identified in 3.1.2.2.2. and 3.1.2.3.2. above.

#### Hypothesis and findings:

It was expected that each subject's most advanced class grouping procedure would be positively correlated with his/her correspondence grouping procedure.

Table 14: Subjects' Most Co-ordinated Spontaneous Class Grouping Procedure by their Most Co-ordinated Correspondence Procedure

	<u>Class</u>	<u>Grouping</u>	<u>Procedure</u>
	A	A-B	ABA
<u>Correspondence Procedure</u>			
Unco-ordinated: None	4	6	1
Single	2	7	1
Successive	1	6	1
Co-ordinated:	-	1	1
<u>Note:</u>			
A	items from only one class		
A-B	two classes one at a time		
ABA	mixed order		

Table 14 summarises the results of this comparison. A Spearman's rankorder correlation revealed no significant association between grouping procedures on classes or correspondences ( $r_s = .286, p > .05$ ).

Comparison with previous studies:

Sugarman (1983) found a significant correlation between spontaneous class groupings and correspondence procedure. However, this correlation was not significant when she controlled for age.

In the present study, age was not significantly associated with either class grouping procedure or correspondence procedure as in Sugarman (1983) and the results are therefore similar.

Summary Comparison of Types of Consistent Construction

The main results of the comparison of classes and correspondences were as follows:

- (1) Half the subjects who grouped two classes inclusively also produced inclusive between-class correspondences.
- (2) Class grouping procedure was not correlated significantly with correspondence grouping procedure.

3.1.3. Spatial Constructions - Bidimensional

It was argued in 3.1.2.2. that grouping two mutually exclusive subsets in mixed order indicates that the subject is seeing the objects from two perspectives at once (i.e. is it x or not, is it y or not; or, if it is not x it may be y). Subjects who could do this successfully should therefore also be able to group on the basis of two dimensions simultaneously - multiple classification (Inhelder and Piaget, 1964). If so, this would provide

additional evidence for the position that mixed order production of consistent constructions requires this co-ordination of concepts.

Data for this analysis was derived from Task II in which form (column/cylinder) and colour (white/green) varied independently.


### 3.1.3.1. Products


#### 3.1.3.1.1. Number of bidimensionally consistent subclasses

A subclass was defined as any two objects in combination according to form, colour or colour and form. The total number of bidimensionally consistent subclasses was of interest because certain types of subclasses, though bidimensionally consistent, might reflect attention to only one class criterion at a time. For example, two forms of the same colour; or all four objects of the same form or same colour could be generated by attending to only one class basis. However, this would not be possible with four bidimensionally consistent subclasses.

#### Coding and scoring:

Each subject's highest number of bidimensionally consistent subclasses was noted. For this purpose the classical matrix with its form/colour separation was accepted target behaviour, as was form/colour symmetry, eg.

or  .



Hypothesis and findings:

It was expected that the highest number of bidimensionally consistent subclasses produced by each subject would be positively related to age. Groups C and D were therefore expected to produce more bidimensionally consistent subclasses than Groups A and B.

Table 15: Number of Subjects in Each Age Group Using Different Numbers of Bidimensionally Consistent Subclasses

Group	A 16-23m	B 24-30m	C 31-36m	D 37-42m
N. Subclasses				
0	1	2	2	1
1	6	3	2	1
2	1	2	-	-
3	-	-	-	-
4	-	1	4	5

As seen in Table 15, none of Group A and only one subject in Group B did more than group one or two subclasses.

However, 50% and 71% of Groups C and D respectively grouped all four subclasses. This trend is significant for Groups C and D combined compared with Groups A and B ( $\chi^2 = 10,2355$ ,  $df 1$ ,  $p < .01$ ) for categories 0, 1 and 2 subclasses combined compared with 4 subclasses. The hypothesis was therefore accepted.

Age and number of bidimensionally consistent subclasses were significantly correlated ( $r_s = .32$ ,  $p < .05$ ).

The relation between bidimensional consistency and number of subclasses was positive. No subject in this study

produced a two subclass configuration which would have required the co-ordination of two dimensions (eg. ■■○○ or ●●□□). The most common dimension for the organisation of two subclasses was form only.

Comparison with previous studies:

These findings are in agreement with Sugarman (1983) who found an age related increase in number of subclasses. In her study only one percent of two subclass constructions included objects differing in both colour and form, form alone being the most salient basis of grouping.

3.1.3.1.2. Most consistent construction with four subclasses

This provided a measure of the level of consistency of constructions using all four subclasses.

Coding and scoring:

Constructions were categorised as follows:

- (1) No constructions with all four subclasses (i.e. all eight objects);
- (2) Totally mixed (all objects used but inconsistently);
- (3) Consistent for form or colour;
- (4) Consistent for both form and colour.

Hypothesis and findings:

Groups C and D were expected to produce constructions with a higher level of bidimensional consistency than Groups A and B.


Table 16: Number of Subjects at Different Ages in Each Response Category for Constructions with Four Subclasses

Group	A	B	C	D
	16-23m	24-30m	31-36m	37-42m
None	7	6	3	1
Totally mixed	1	1	1	1
Consistent form or colour	-	1	2	-
Consistent form and colour	-	-	2	5

The relationship of age to consistency on both dimensions is seen in Table 16.

This was significant for Groups C and D combined compared with Groups A and B for the combined response categories - no types with four subclasses or totally mixed vs consistent constructions ( $\chi^2 = 10,235$ ,  $df 1$ ,  $p < .01$ ). Age was positively correlated with level of consistency ( $r_s = .624$ ,  $p < .01$ ).

While these statistics reflect the large number of constructions in Groups A and B which did not include all objects, the fact that no constructions with two subclasses were constructed on the basis of both dimensions indicates that scoring these responses at a lower level was justified.

Constructions with four subclasses were produced by ten subjects, one of whom produced a completely cross-classified arrangement. Five subjects produced symmetrical arrangements. The remaining subjects produced arrangements which did not conform to a matrix pattern but incorporated systematic colour/form patterning (e.g. ).

Comparison with previous studies:

This pattern of increasing consistency is similar to Sugarman's (1983) findings though her data base was larger (two tasks). However, there appears to be some developmental lag between her subjects and those in this study. Twelve of her 16 subjects under 30 months grouped all four subclasses consistently on at least one dimension, whereas in the present study only one subject under 30 months old did.

3.1.3.2. Grouping procedure

Because of the small number of bidimensionally consistent constructions with four subclasses, no statistical analysis was done. Some observations of grouping procedure indicate the levels of object comparisons subjects were making.

Hypothesis and findings:

It was expected that an investigation of the way these constructions were produced might reveal that some subjects were able to shift between dimensions, indicating a co-ordination of object comparisons.

Most subjects used the simplest possible method of generating a consistent construction with four subclasses. Five subjects placed all objects sharing one value on one dimension first (e.g. both white cylinders, then both green cylinders). Two subjects shifted between form and colour values in a systematic arrangement. Two others

also shifted between dimensions but this pattern seemed to relate to overlooking and then integrating certain objects. For example, one subject first placed three cylinders, then four columns and then the final cylinder. Nevertheless, all of the procedures above required a level of co-ordination in finding the right position for a form of a particular colour.

#### Comparison with previous studies:

The method of producing most of these constructions was the same as that employed by subjects in Sugarman (1983) and lends support to the central role of perceptual supports in multiple classification (Inhelder and Piaget, 1964). However, despite perceptual cues, subjects appear to have been considering both dimensions of objects in relation to their position in space. This point will be returned to in Chapter 4.

#### 3.1.3.3. Comparison of bidimensional and unidimensional constructions

It was suggested that the ability to classify bidimensionally requires the same ability to co-ordinate comparisons of objects needed to generate mixed order groupings of two mutually exclusive subsets. If so, there should be some consistency in individual performance on these two kinds of tasks.

As there were so few co-ordinated responses, this data was not analysed statistically.

Hypothesis and findings:

It was expected that there would be a degree of consistency in individual performance on bidimensional and unidimensional grouping tasks.

Of seven subjects who grouped bidimensionally, two spontaneously co-ordinated unidimensional between-class correspondences or class groupings. As the number of subjects who spontaneously grouped in mixed order was so low (five for both correspondence and class grouping together), the results of the elicited grouping task were used as an alternative measure of co-ordinated unidimensional grouping. All subjects who achieved bidimensionally consistent groups also grouped in mixed order when this was elicited.

Twenty-one subjects engaged in no spontaneous co-ordination, either unidimensional or bidimensional, and ten of these failed to group in mixed order on the elicited grouping task. It appears then that there is tentative evidence that similar cognitive organisation is used in mixed order unidimensional grouping and the production of bidimensionally consistent groupings.

Comparison with previous studies:

Sugarman (1983) found a greater degree of individual consistency of co-ordinated responses than in the present study. This clearly reflects the low incidence of spontaneous mixed order grouping on one dimension in this study. In general, both studies support the conclusion

(Inhelder and Piaget, 1964) that unidimensional and multidimensional classification skills develop simultaneously.

#### Summary Bidimensional Constructions

The major findings in this section are as follows:

(1) Groups C and D have significantly greater numbers of bidimensionally consistent subclasses in their constructions than Groups A and B.

(2) Groups C and D have a higher level of bidimensional consistency in their constructions with four subclasses than Groups A and B.

(3) In producing bidimensionally consistent constructions with four subclasses, subjects relied heavily on perceptual cues.

(4) There is some degree of individual consistency in co-ordinated unidimensional grouping and the production of bidimensionally consistent constructions.

#### 3.1.4. Verbal Expressions of Class Relations

This section looks for parallel trends in manipulative classification and subjects' verbal expressions about class relations. If these were found to parallel each other, it would suggest a trend in conceptual organisation which transcends particular modes of expression.

Coding and scoring:

All videotapes of experimental sessions included soundtrack and each subject's task-related utterances were transcribed and categorised in accordance with Sugarman (1983) as follows:

- 0 No reference
- 1 Isolated reference only, e.g. spoon, kar, blokkie
- 2 Iterative reference: one-class, e.g. block ... also a block; bakkie ... meer bakkie
- 3 Iterative reference: two-class, e.g. here's a car, your car and here's Andrew's car and that spoon and that is fork
- 4 Co-ordinated reference to two classes, e.g. two colours build same colour; where is the white one like that (pointing to green).

Hypothesis and findings:

A positive relation between age and level of verbal reference to class relations was expected.

Table 17: Number of Subjects in Different Response Categories for Verbal Reference to Class Relations

Group	A	B	C	D
	16-23m	24-30m	31-36m	37-42m
No reference	6	7	3	5
Isolated reference	2	1	1	1
Iterative one-class	-	-	3	-
Iterative two-class	-	-	1	1
Co-ordinated reference	-	-	-	-

As summarised in Table 17, 10 subjects made spontaneous verbal reference to the classes they were manipulating. The difference between the number of younger (Groups A and B combined) and older (Groups C and D) subjects who verbalised was not significant ( $\chi^2 = 2,76$ ,  $df\ 1$ ,  $p > .1$ ).

A Spearman's rank order correlation between age and highest level of verbal reference by the 10 subjects who did verbalise was significant ( $r_s = .61$ ,  $p < .05$ ).

At all ages subjects mostly used isolated names. Four of the five subjects who used iterative forms of reference also labelled isolated objects. The youngest subject who commented on similarity was 33 months, by which age all the subjects who verbalised were producing consistent constructions with two classes. Two of the subjects over 33 months who grouped two classes successively made iterative reference to two classes.

While the data is too sparse to represent more than a pilot study, there are two tentative conclusions to be drawn from it. Firstly, the fact that subjects engaging in iterative reference to two classes also made iterative reference to one class and isolated reference, and likewise those referring successively to one class also referred to isolated items, seems to imply a developmental sequence. This parallels the sequence in which spatial and temporal groupings develop. Secondly, verbal class reference did not appear to depend on spatial arrangement of objects.

Comparison with previous studies:

The base for the analysis of verbal reference in this study is far more limited than Sugarman (1983) who included data from an additional 10-15 minute free play session and this limits the comparability of this aspect of the studies.

One major difference between Sugarman (1983) and the present study was that she found that many subjects spontaneously commented on class relations among the materials (31 of 32 subjects over 18 months). In this study, only one-third of the subjects verbalised at all during the experimental sessions.

Experience with children from Kewtown has led to the observation by ELC staff that, within the whole preschool age range they deal with, children appear to be more comfortable with and perform more successfully on manipulative than verbal activities. This is especially true of the younger children (6 months to 3 years) who seldom engage in verbal activity that is not labelling (action or object) or need-oriented. This finding is common to similar disadvantaged communities (Bernstein, 1970; Bee, Van Egeren, Streissguth, Nyman and Leckie, 1969; Hess and Shipman, 1965). Lack of verbalisation does not appear to have been the result of anxiety in the experimental situation - presence of a second familiar adult did not have any apparent effect on amount of verbalisation as only 2 of those 10 who verbalised had a second familiar adult with them. However, the fact that

the child was in an adult-child dyad may well have limited his verbalisation (peer conversation is more common in this group), as might the fact that the task lent itself to manipulative activity.

A comparison of those verbal references made reveals certain parallels between the two studies. Sugarman (1983) too found the same developmental progression of level of reference and the independence of verbal reference and spatial constructions. She did, however, find that nearly 70% of her subjects over 30 months used co-ordinated forms of reference, a form totally absent in this study.

#### Summary Verbal Expressions of Class Relations

The main findings in this section were:

- (1) Only one-third of subjects referred verbally to classes.
- (2) There was a significant correlation between age and level of reference to class relations for those subjects who engaged in verbalisation.
- (3) The data suggests a developmental sequence of levels of class reference which is similar to that in the development of spatial class grouping procedure. However, these do not entirely overlap in performance.

### 3.2. PART TWO: EFFECTS OF TASK CHARACTERISTICS ON OBJECT GROUPING BEHAVIOUR

In 1.2. above, literature was reviewed which suggested that cognitive skills are more specific than some accounts (notably Piaget) would allow and depend heavily on environmental characteristics. This section of the study therefore focusses on the effects of specific materials on grouping responses. Materials were chosen to allow grouping on the basis of perceptual and functional attributes and for comparability with previous studies of early grouping behaviour (see 2.1.2. above for details).

#### Method of analysis:

Subjects' scores on the different tasks were tested for differences using Friedman's two-way analysis of variance by ranks for repeated measures. This technique has a drawback in that it cannot measure interaction. It was therefore necessary to test each age group separately as well. This was done both within each age group for all tasks (to test for differential effects of each task in the four age groups), and between the four age groups for each task separately. For the latter analysis, a Kruskal-Wallis one-way analysis of variance by ranks was used.

Coding and scoring followed the categories used in Part One (3.1.).

#### 3.2.1. Preliminary Analyses

Both the length of allocated time spent on each task and the relative salience of different subsets of materials on

each task are examined here because they may be useful in accounting for any task differences found in the major analyses below.

### 3.2.1.1. Time used on each task

Table 18: Mean Number of Seconds per Task for the Different Age Groups

Group	A	B	C	D
	16-23m	24-30m	31-36m	37-42m
Task I	112,5(19,8)	112,9(10,1)	115,6(8,5)	118,9(1,9)
Task II	112(17,7)	90(34,4)	74,4(26)	96,7(12,4)
Task III	111,8(10,8)	105,5(23,1)	106,6(19,2)	83,6(12,9)
Task IV	105(23)	81,3(32,9)	80(34)	83,1(25,3)
Task V	116,9(6,6)	118,8(3,3)	104,9(17,5)	90,6(31,4)

Note: Standard deviations are given in brackets.

Average times per task are indicated in Table 18. All subjects did not complete the full two minutes allowed them per task and overall there was a negative Pearson correlation ( $r = .44$ ,  $p < .02$ ) between age and total time spent on tasks. This may indicate a level of boredom in the older subjects but the impression gained by the experimenter was that older subjects were looking for the "answer" to the problem (possibly to please the experimenter) and having found one, lost interest. In addition, younger subjects took longer to arrange objects because of their less advanced manipulatory skills. A general factor which influenced time spent at all ages was the type of object, for example, on Task I, cars elicited a great amount of repetitive manipulation, and blocks (Task III) elicited stacking.

### 3.2.1.2. Saliience

A study of the percentage of moves per task involving each subset of materials indicates that certain items were more salient than others. Table 19 gives the number of subjects who manipulated a particular subset for 67 or more percent of their total moves on that task.

Table 19: Number of Subjects Manipulating One Subset for More than 67% of their Moves on a Task

		Subset A	Subset B
Task I	cars/eating utensils	12	7
Task II	columns/cylinders	1	7
Task III	triangles/hexagons	3	5
Task IV	blocks/plates	18	2
Task V	animals/furniture	1	12

It is apparent that certain items were more salient and this undoubtedly influenced the formation of one-class groupings. On Task I, the cars elicited a great deal of manipulation as did placing the furniture on Task V. The results for Task IV are, however, a little misleading as the blocks were frequently placed on the plates and this would partially, at least, account for the greater amount of manipulation of this subset. However, as has been shown in 3.1.2. above, with increasing age two-class constructions became more frequent, despite greater saliience of one subset.

### 3.2.2. Task Effects on Sequential Ordering of Classes

Each subject's longest ordering sequence on each task was coded according to the categories given in 3.1. These were compared using Friedman's two-way analysis of variance.

#### Hypothesis and findings:

Task differences in the highest level of sequential ordering were expected.

Differences between tasks on longest sequential ordering were significant ( $\chi^2 = 14,04$ ,  $df\ 4$ ,  $p < .02$  two tailed). Subjects had the longest sequences on Task IV and the shortest on Task II.

#### Comparison with previous studies:

Previous studies of sequential ordering (Ricciuti, 1965; Starkey, 1981) found that the greater the number of dimensions of difference between subsets the more ordering they elicited. In this study, Task IV materials differed on dimensions of form, colour and size which supports their findings. However, the concept of multiple contrast cannot explain why Task III, which differed in form only, elicited longer ordering sequences than Task II which differed on two dimensions. This suggests that factors other than contrast also have a role in determining length of ordering sequence. It is possible that colour/form confusion on the cross-classified Task II materials inhibited ordering behaviour.

### 3.2.3. Task Effects on Spatial Constructions

#### 3.2.3.1. Products

##### 3.2.3.1.1. Base rate

The total number of constructions did not vary significantly across tasks for the whole sample ( $\chi^2 = 7.58$ ,  $df\ 4$ ,  $p > .1$ ), nor at the four particular age levels. The lowest number of constructions was produced on Task III (triangle/hexagon) and the highest on Task IV (blocks/plates). As the difference between tasks approached significance, it was considered advisable to standardise the number of constructions to allow for a more accurate comparison of the relative frequency of different types of construction on the five tasks. This was done by converting the frequency of each type of grouping on a task to a percentage of the total constructions on that task. This percentage was then used in all the statistical analyses reported below.

##### 3.2.3.1.2. Task and type of grouping

This section examines whether particular materials elicit particular grouping behaviours. The choice of materials in this study aimed at class consistent behaviour but within that framework different objects elicited different forms of grouping. These are summarised in Table 20:

Table 20: Number of Responses in Each Category of Construction for the Five Tasks

	Total	Class	Correspondence	Symmetry	Mixed
Task I	95	84 (88)	1 (1)	1 (1)	9 (10)
Task II	80	52 (65)	1 (1)	6 (8)	21 (26)
Task III	65	44 (68)	1 (1)	2 (3)	18 (28)
Task IV	100	63 (63)	25 (25)	1 (1)	11 (11)
Task V	95	72 (76)	7 (7)	-	16 (17)
Total	435	315 (73)	35 (8)	10 (2)	75 (17)

Note: The rounded-off percentage of the total frequency on each task is indicated in brackets.

As Table 20 indicates, class constructions were most common for all tasks. Correspondences were most frequent on Task IV which allowed for containment of one subset by the other, followed by Task V which allowed for a functional correspondence of animals to furniture. Symmetry was most frequent on Task II which was bidimensional.

Comparison with previous studies:

Sugarman (1983) also reported that sets of materials allowing containment encouraged correspondences. Symmetries were, however, no more frequent in the bidimensional condition than with materials that varied on a single dimension.

The descriptive data from this study support Forman (1982a) who maintains that the "physical properties of a class of objects define a constrained range of possible significations" which activate certain schemes but not others (p. 335) - an idea which Gibson (1979) has

developed into a theory of the "affordance" of objects.

### 3.2.3.1.3. Task effects on consistency of constructions

Only major statistical values are included in the text, a full account of values is given in Appendix D.

#### Hypotheses and findings:

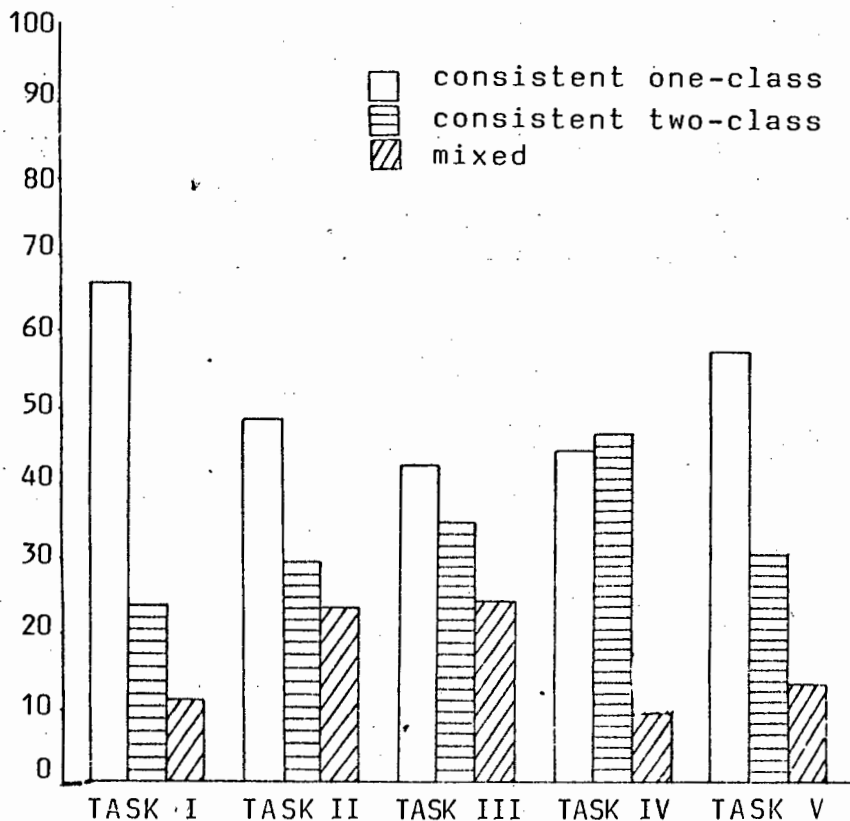
The following task effects were hypothesised:

(1) The percentage of consistent constructions, one- and two-class, was expected to vary for Tasks I, II, III, IV and V.

(2) Real materials (Tasks I and V) were expected to elicit a higher percentage of consistent constructions than geometric materials (Tasks II and III).

Only major or significant statistical values are reported in the text. A full list of all statistics computed is given in Appendix D.

Figure 5: Mean Percentage of Consistent One- and Two-Class, and Mixed Constructions for Each Task



(1) Contrary to expectations it was found that the percentage of consistent constructions did not vary significantly across tasks for the subjects as a whole ( $\chi^2 = 7,85$ ,  $df\ 4$ ,  $p < .1$ ). This value does, however, approach significance. The majority of consistent constructions, as can be seen in Figure 5, was for Task IV (blocks and plates) followed by Task I (cars and eating utensils) and Task V (animals and furniture). Mixed constructions were proportionately most common - 24% and 23% on Tasks III (triangles and hexagons) and II (cylinders and columns) respectively.

The number of mixed responses on Task III may be due to the number of stacking responses these materials elicited. This typical response pattern to blocks made it more difficult for children to "correct" the array than in other tasks and a number of the consistent constructions were coded transitional as a result. Many mixed responses on Task II appear to result from colour/form confusion. This was particularly apparent in the elicited grouping task (cf. 3.1.2.2.2.(b)(i) above) where mixed order grouping constructions showed a great deal of partial alignments (Inhelder and Piaget, 1964). This occurred when the child began a construction based on form and switched to colour midway etc.

Further analysis revealed that task differences for the percentage of one-class constructions were not significant ( $\chi^2 = 8,174$ ,  $df\ 4$ ,  $p < .1$ ) for the sample as a whole, though they tended in that direction. There were no differences

within specific age levels. Task I had the most one-class constructions (66%) followed by Task V (57%).

Task effects were not significant for the percentage of two-class constructions either for the sample as a whole ( $Xr^2 = 4,24$ ,  $df\ 4$ ,  $p > .3$ ) or within age levels, and the hypothesis was not accepted. Most two-class responses were produced on Task IV.

(2) The comparison of real and geometric materials was based on Tasks II and III (geometric) and I and V (real). Task IV was omitted as it was apparent that some children had responded to it as a functional class and others on the basis of its geometric properties.

A Wilcoxon matched-pairs signed ranks test was computed on the percentage of consistent constructions for real as opposed to geometric materials. This was significantly greater for real than geometric materials ( $z = 2,198$ ,  $p = .0122$ ). Though the real materials elicited more consistent constructions, the difference was significant only for one-class constructions ( $z = 2,152$ ,  $p = .0158$ ) and may reflect the greater salience of particular subsets of these materials. Differences in the percentage of two-class constructions were not significant for real/geometric materials - further evidence for the salience view.

Nevertheless, all items in the real groups were varied which could be seen as indicating a functional rather than perceptual basis for the constructions. Smith (1979) has indicated that children classify on overall similarity and

it could be argued that the overall within-class similarity was greater than that between classes. However, the types of fantasy play elicited by the materials by subjects at all ages suggests that they were responding to the functional basis of the grouping.

Comparison with previous studies:

Both Ricciuti (1965) and Starkey (1981) report that the greater the number of dimensions of difference between objects, the greater the amount of grouping behaviour was likely. Materials for Task III in this study, which varied on form only, were based on Ricciuti and, as he found, elicited the least consistent groupings.

Sugarman (1983) reports that subjects under 24 months were confused by colour/form noise in her bidimensional tasks but that subjects over 30 months produced more consistent groupings in the bidimensional condition. In this study, this was not the case; the proportion of mixed responses did not differ according to age, though older subjects produced more two-class groupings. In both studies, form predominated over colour as a basis for grouping, which is in line with previous research (Brian and Goodenough, 1929; Descourdes, 1914 cited by Sugarman, 1983, p. 11; Casey, 1979; Sugarman, 1983).

The finding that function was a salient principle of grouping confirms Nelson (1973) who found that children around two years grouped objects according to their function more often than size or colour grouping.

3.2.3.1.4. Task effects on constructions at different ages

Each task was examined separately for its effect at different ages on consistency, percentage of one- and two-class and mixed constructions, using a Kruskal-Wallis one-way analysis of variance.

Hypothesis and findings:

It was expected that there would be a differential effect on all tasks in the direction of a decrease in mixed constructions and increasing consistency of the two-class type with increasing age. However, certain tasks might show this in a more pronounced way.

Figure 6: Percentage of Consistent Constructions by Age Groups A,B,C,D for Each Task

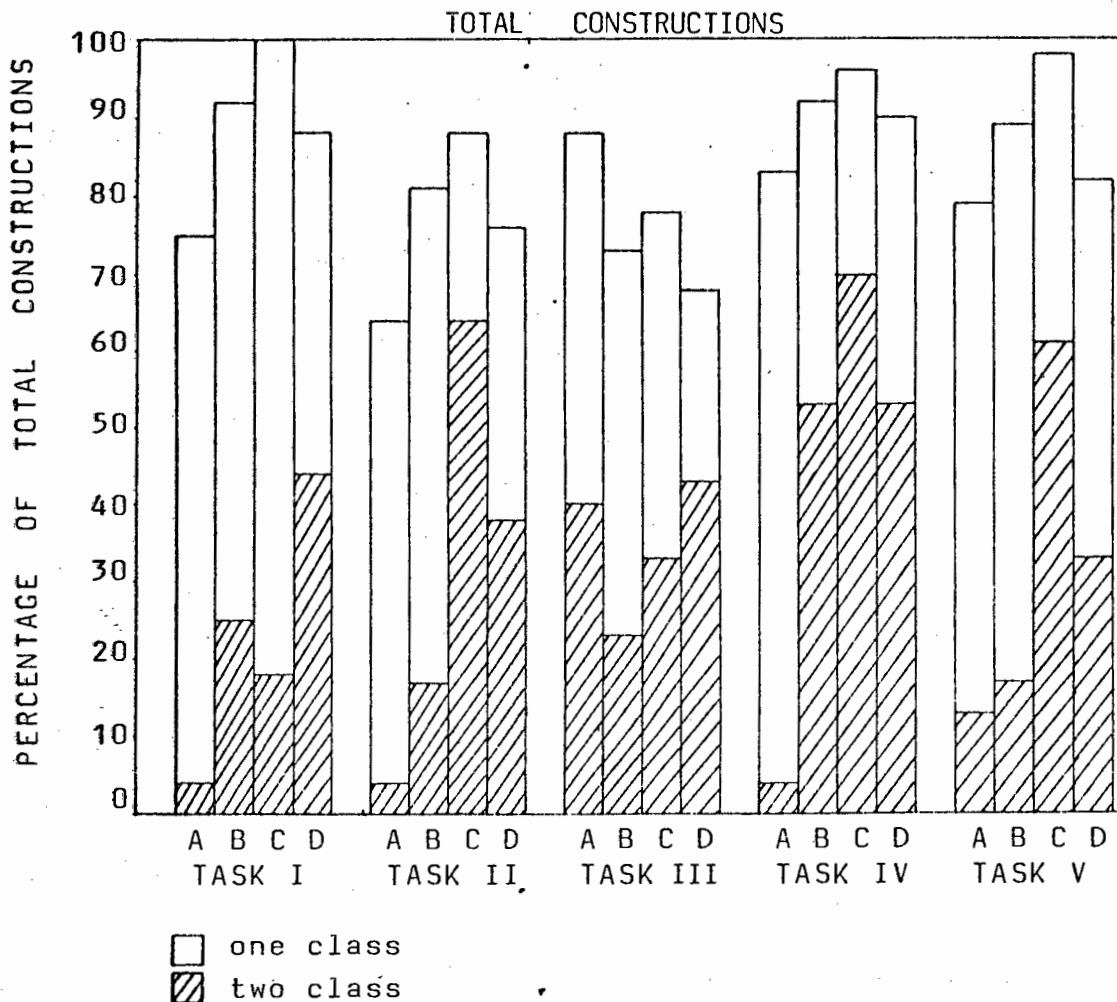


Figure 6 indicates the relative proportions of mixed and consistent constructions for each age group on each task.

With the exception of Task I, for which Group C had a significantly lower percentage of mixed responses ( $H = 7,8559$ ,  $df\ 3$ ,  $p < .05$ ), there were no differences in percentage of mixed responses for Groups A, B, C and D on any task though the percentage of mixed constructions on Task V approaches significance, Group C having the lowest percentage.

On Task IV there were significant differences in percentage of one-class constructions ( $H = 10,561$ ,  $df\ 3$ ,  $p < .02$ ) with Group A producing the majority of these. There were no differences on the other tasks.

The percentage of two-class constructions varied significantly for Tasks II ( $H = 11,214$ ,  $p < .02$ ), IV ( $H = 15,2$ ,  $df\ 3$ ,  $p < .01$ ) and V ( $H = 9,8459$ ,  $df\ 3$ ,  $p < .02$ ) on all of which Group A had the lowest percentage.

These results indicate a trend towards more inclusive groupings with increasing age, but with Group C achieving higher levels than Group D.

#### Comparison with previous studies:

These findings are generally in the same direction as Sugarman (1983) who found that developmental trends in consistency were preserved regardless of task differences.

### 3.2.3.2. Grouping procedure

As only six subjects in this study used co-ordinated grouping procedures, the results are presented descriptively without statistical analysis. Five of the two-class constructions on Task II were produced in a co-ordinated way, two on Task III and one on Task IV. It would be rash to draw conclusions from such a limited data base, but it is possible that the conflicting colour/form cues of Task II were the cause of the mixed order grouping procedure.

### Summary Task Effects on Object Grouping Behaviour

Preliminary analyses:

- (1) Time spent by each subject on the tasks was negatively correlated with age ( $r = -.44$ ,  $df\ 29$ ,  $p < .02$ ).
- (2) Certain subsets of materials - cars, blocks and furniture - were more salient than others for nearly 40% of subjects. The criterion was that 67% of moves on that task involved them.

The major differences on grouping behaviour for the five different tasks were as follows:

- (1) There were significant task effects on longest sequential ordering sequence, the most on Task IV and the least on Task II.
- (2) There were no differences in the total percentage of consistent constructions across tasks or for the percentage of one or two classes separately.
- (3) Correspondence groupings were most frequent with Task IV materials which permitted containment. Symmetries on Task II had bidimensional grouping criteria.

(4) Comparisons of real/geometric materials showed a significantly higher percentage of consistent constructions for real materials. This, however, was limited to one-class constructions.

(5) Examining the effects of each task for Groups A, B, C and D revealed few significant differences and those that there were tended in the direction of increasingly consistent groupings. Group C had significantly fewer mixed constructions on Task I, Group A the most one-class constructions on Task IV and older subjects had a significantly higher percentage of two-class constructions on Tasks II, IV and V.

#### 4. DISCUSSION

- 4.1. OVERALL TRENDS IN GROUPING BEHAVIOUR: A COMPARISON OF YOUNG CHILDREN FROM LOW AND MIDDLE LEVEL SOCIO-ECONOMIC BACKGROUNDS
  - 4.1.1. Grouping According to Unidimensional Criteria - Temporal and Spatial Constructions
  - 4.1.2. Evidence for Co-ordinated Grouping Procedure
  - 4.1.3. Grouping According to Bidimensional Criteria
  - 4.1.4. Verbal Expressions of Class Relations
  
- 4.2. TASK EFFECTS ON THE GROUPING BEHAVIOUR OF YOUNG CHILDREN FROM A LOW SOCIO-ECONOMIC BACKGROUND
  
- 4.3. METHODOLOGICAL CONSIDERATIONS
  - 4.3.1. Design
  - 4.3.2. Coding
  - 4.3.3. Experimental Procedure
  
- 4.4. QUESTIONS FOR FUTURE RESEARCH

#### 4. DISCUSSION

In this section, the results of the two parts of the study are discussed in relation to the broader context of knowledge about the cognitive skills of lower-class children. Firstly, what has been learned about the object grouping behaviour of young low income children is compared with what is known about this behaviour in middle-class children, with particular reference to Sugarman's (1983) procedural method. Secondly, the implications of differential effects of specific materials on grouping behaviour in low income children are considered.

In comparing the grouping behaviour of this low income sample with that shown by middle-class children in previous studies, it is recognised that children in this sample may have an advantage over other low income children who do not attend day care centres, in addition to the advantage brought by familiarity with the testing situation discussed in 2.1. For example, ELC children are familiar with geometric blocks and have experience in interacting with a variety of colourful playthings. It is therefore justifiable to expect that they may perform at a somewhat higher level than lower-class children who do not have access to such materials.

#### 4.1. OVERALL TRENDS IN GROUPING BEHAVIOUR: A COMPARISON OF YOUNG CHILDREN FROM LOW AND MIDDLE LEVEL SOCIO-ECONOMIC BACKGROUNDS

##### 4.1.1. Grouping According to Unidimensional Criteria - Temporal and Spatial Constructions

As discussed in 1.3, it is in this age range that social class differences emerge on a variety of cognitive tasks. In this sample, developmental trends in object groupings (both temporal and spatial) from partial one-class to two-class groupings which include all available items are in line with those found in studies of middle income children of similar ages (Ricciuti, 1965; Starkey, 1981; Sugarman, 1983).

There is some indication though that children in this study may be slower in their rate of progression through these stages than those in the Sugarman study which it most closely follows. While the percentage of consistent constructions produced in this study was higher, there were fewer two-class constructions than in Sugarman's study (see 3.1.2.) and a greater proportion of one-class groups. This may reflect a greater reliance on salience as the basis of grouping and could have inflated consistency levels, though it has been noted that materials used were not exactly the same. Another indication of difference was in the relative size of constructions at different ages, with subjects in this study producing smaller constructions than Sugarman's subjects at comparable ages. It therefore appears that

despite the advantages of the day care situation, the observed age-related changes in this sample of low income children are slower than those observed in previously studied middle-class children. This may mean that concepts are developing more slowly or probably (Lesser, Fifer and Clark, 1965) that they are not readily accessible to these children in the experimental situation.

#### 4.1.2. Evidence for Co-ordinated Grouping Procedure

The question is now addressed of whether the study produced any evidence in support of Sugarman's theory of a phase of co-ordination of relations between objects - a phase which goes beyond what traditional Piagetian theory suggests, and which her time-consuming move-by-move method of analysis was intended to reveal.

As was discussed in 3.1.2.5., only five subjects grouped in the mixed order pattern and they were not clustered in the higher age groups. There are various factors which may account for this and it is not easy to decide on their relative contribution to this finding. Firstly, if the "developmental lag" approach is taken, it could be argued that the upper age limit of the study was too low for this behaviour to be evident, and that the high percentage of one-class groupings would have limited the amount of mixed-order grouping that could have taken place. Alternatively, it could be argued that Sugarman's assumption that mixed order grouping reflects co-ordination of interobject comparisons is a tenuous one and that even

with her large data base, this is not a frequent spontaneous behaviour (the mean percentage of two-class constructions produced in mixed order was 0,3, 1,4 and 2,6 at 24, 30 and 36 months respectively). However, a higher age limit to her study might have indicated that this behaviour was just emerging and there is evidence of co-ordination of concepts in language studies (those cited in 1.2. and also Nelson, 1976), and also in combinatorial sociodramatic play in which the same scheme is directed to two or more recipients, a behaviour typically seen by 24 months (Fenson and Ramsey, 1980).

The paucity of constructions produced in this way in spontaneous play should be considered further in light of the striking differences between Sugarman's subjects and those in this study on tasks designed to elicit this behaviour.

As discussed in 3.1.2.2.2.(b), this concept of mixed order grouping became accessible (cf. Flavell, 1970) to the low income subjects of this study when the situation was structured to provide cues for its elicitation. A significant number of subjects improved their performance on the elicited grouping task, whereas in Sugarman's sample, performance on the elicited grouping task mirrored their spontaneous performance.

If the view is taken that this does represent a stage in the development of classification and indeed of other cognitive skills, as the evidence discussed above suggests

one should, it could be accounted for in two ways.

Firstly, research (Lesser, Fifer and Clark, 1965) has indicated that there are differences in the patterns of thought of children from different cultures and social classes which seem, in the case of social class differences, to relate to performance factors. Seltzer (1973) describes a study in which he found that lower-class subjects aged three months to two years tended to form a "response set" much more quickly than middle-class children on a grouping task. As this difference, though large, was not statistically reliable, Seltzer's hypothesis is at best a tentative one. However, it may suggest a line of inquiry as to the differential accessibility of this skill in spontaneous play and the elicited situation in that a preference for the more common successive grouping form might have been established. Observation during the study suggests that subjects were searching for the "right" answer as once they had found a solution, they were often reluctant to continue playing. This tendency was more evident in older children, as seen in the negative correlation between age and amount of time spent on each task. It is precisely in this older age range, when the preferences appear to be most fixed, that the mixed order grouping should be most evident. Similarly, the lack of response on the Misplacement Task, which followed the Elicited Grouping Task, could be accounted for by the view that subjects had developed a response set of mixed order grouping and could not apply a different

strategy immediately. Further empirical investigation of this hypothesis of response set is essential to clarify whether or not it plays a role in determining performance on object grouping and other cognitive tasks.

There is an alternative explanation which should be explored and it is this: the tasks might have acted as "schooling" or trained the subjects in the use of the skill. The Russian school in the Vygotskian tradition extols the value of schooling in the developmental process. Briefly, this view (Vygotsky, 1978) holds that developmental processes and learning processes do not coincide, development lagging behind learning. This sequence results in zones of "proximal development" where the functions lie in embryonic state. With leading questions or an initiated solution the child can be shown how the problem is to be solved. Could the elicitation tasks be seen as this kind of cue? As feedback trials to subjects who did not grasp what was expected during the elicitation tasks did little to improve performance levels, and as there was no apparent carry-over effect of the elicitation tasks into spontaneous performance, it seems that the schooling hypothesis lacks explanatory value.

It appears then that subjects had the skill but that it was not available until the structured situation elicited it. If this was so, it may in part have resulted from the very day care situation which was expected to provide some advantages for the sample. For example, matching games are one of the more popular games staff play with the very

young children and this could have helped to develop this type of set when playing with materials.

Before leaving this point, it is worth asking what the value of this Phase 4 - co-ordination of interobject comparisons - may be for the development of classification and cognitive skills as a whole. Perhaps it is a dispensable step in the process evident only under certain conditions. If, as has been suggested, the relative absence or late emergence of this skill may be linked to the inability to move from one response set to another, this would have implications for the development of true classification which requires the understanding that objects can have multiple class membership.

#### 4.1.3. Grouping According to Bidimensional Criteria

The fact that 71% of subjects from 37 months could produce bidimensionally consistent constructions even though this behaviour too appeared later than in Sugarman's (1983) subjects, adds to the evidence that children in the fourth year can process two dimensions of objects. This skill suggests that there is a level of co-ordination of these two dimensions.

The issue though is the extent to which this is purely perceptually based, as Inhelder and Piaget (1964) maintain. Indications from the grouping procedure used both here and in Sugarman's study suggest that most subjects used the simplest method of object placement (usually colour within

the form dimension). Very few managed to shift between form and colour values when grouping and this lends support to the perceptual view. In particular, most of the bidimensionally consistent constructions were symmetries and were formed on the basis of pairwise comparisons. However, in his discussion of reiterative symmetry (i.e. an object placed to balance its counterpart), Forman (1982b) has suggested that this goes beyond the purely perceptual matching stage. The expression of similarity is non-contiguous, it is transposed, and varies according to the position and type of object placed beside the centre. This "suggests the beginning of a continued dissociation that ultimately leads to the dissociation of relations from content. Reiterative symmetry is an expression somewhere between contiguity and pure relation as it does call for a particular shape and is thereby not content free" (p. 127). This appears to be what is operating in these bidimensional classifications which seem to exceed purely perceptual requirements (even though performance relies on perceptual cues) in that they require co-ordination of two dimensions in relation to a particular locus. Further evidence that this is not merely a perceptual skill at this age comes from a study (Biersteker, 1983) of older ELC children's matrix solving abilities. The matrices were constructed on the basis of two properties and subjects showed an increasing ability to solve them (33% in the fourth, 62,5% in the fifth and 78,5% in the sixth year) rather than the pattern of a drop in performance around six years from the level of the four-year

olds noted by Inhelder and Piaget and explained in terms of an attempt to solve the problem logically rather than perceptually.

#### 4.1.4. Verbal Expressions of Class Relations

As discussed in 3.1.4., there was little verbalisation by this sample, a finding in line with previous studies of lower-class children in an experimental context. Only one subject who displayed co-ordination of concepts in mixed order grouping also verbalised and this was at a lower level than her grouping behaviour. In general, verbalisations were at a lower level than actual grouping procedure. Sugarman (1983) also noted that levels of spatial classification could be attained without the equivalent verbal classification. However, in the absence of a situation in which children verbalise freely, these are tentative comments and no conclusions can be reached about the relationship between subjects' verbal and manual competence in classification.

To summarise, the performance on object grouping tasks of these lower-class children who attend a day care centre followed the same general trends seen in grouping studies of middle-class children as far as they produced increasingly inclusive and consistent object groupings of one and then two classes with increasing age. Furthermore, their performance on tasks requiring co-ordination of object relations, that is, a mixed order grouping task and bidimensional grouping, indicates the same developmental

trends as middle-class samples and adds to the body of evidence that young children are capable of more sophisticated grouping skills than Inhelder and Piaget (1964) suggest.

However, despite attempts to make the testing situation a comfortable and familiar one, and despite the fact that this sample could be expected to perform at a somewhat higher level than lower-class children who did not have day care experiences, there were some of the differences between their performance and that of the middle-class subjects of previous studies. Firstly, their rate of development was somewhat slower than that of middle-class children, and verbalisation was very limited - both findings common in the context of studies of class differences on tests of cognitive development. Secondly, one of the behaviours from which co-ordination of object relations was inferred, mixed order grouping of two classes, was not evident in spontaneous play but could be elicited in a more structured situation. It is suggested that this may be the result of different patterns of thought in these lower-class children.

#### 4.2. TASK EFFECTS ON THE GROUPING BEHAVIOUR OF YOUNG CHILDREN FROM A LOW SOCIO-ECONOMIC BACKGROUND

As the object sets were selected to enable comparison with a number of previous studies, only general comparisons may be drawn. Broadly, there were no great differences between these and previous findings, which is to be expected as this sample was a Western industrial sample which could be

expected to have had experience of objects like the experiences of those in the studies it was designed to compare. Most constructions were on the functional tasks rather than purely form, even around three-and-a-half years. Grouping according to function instead of the more abstract form criteria has often been considered to be a simpler level of response (cf. Glick, 1975) and indeed Holland (1978) notes that it is the more common response in developmentally delayed toddlers compared with non-delayed toddlers. It is possible though that the geometric stimuli elicited alternative schemes such as stacking and upending which overrode the grouping response. This would support Forman's (1982a) suggestion that the physical properties of objects elicit a particular range of responses. Buck-Morss (1975) would suggest that this result reflects the abstract mode of thought of the middle classes.

The fact that an increase in consistency of constructions with age was found on all tasks, indicates that their effects may only be to depress or accelerate the manifestation of a particular skill. In fact, the finding that young children are more competent at grouping tasks than suggested by Inhelder and Piaget (1964) and Vygotsky (1962) appears to be heavily task-related. Tasks in their studies were considerably more complex, involving sorting of a large number of objects with overlapping criteria. What this indicates is that the status of a skill or competence cannot be determined by performance on a

particular task or even on a group of tasks. One can only conclude with Glick (1975) that "we do not know the relationship between cognitive capacities and the conditions of their application" (p. 647).

#### 4.3. METHODOLOGICAL CONSIDERATIONS

##### 4.3.1. Design

An extension of the age range of the subjects to include 12-month olds and children over 42 months would have helped to clarify the issues of when the different rate of development of grouping behaviour in these lower-class children, which is noted in the 16- - 24-month olds, actually emerges and whether spontaneous mixed order grouping does become more frequent with increasing age. In the present study, the range was limited both because of the limited availability of subjects in the younger age groups and because the method of analysis is extremely time consuming.

##### 4.3.2. Coding

In coding the various grouping behaviours, Sugarman's categories were followed. Her "weak" definition of classes which represents a departure from previous studies (e.g. Ricciuti, 1965; Starkey, 1981), has the advantage of increasing the data base and thus enables an analysis of grouping procedure. However, it does present some anomalies. For example, the definition of a class as a group of objects of one class uninterrupted by those of the other renders aabb as a two-class construction, but aaabbbba as mixed. To deal with this, a transitional

category was created, but this still gave a lower rating to aaabbbba than to aabb despite the fact that it is a more inclusive grouping. However, these did not constitute a large portion of the data. If this method of analysis is more widely adopted, a differential weighting of temporal or spatial constructions of various sizes should be considered, but to allow for statistical tests of significance this would require a data base large enough to generate sufficient data for each category.

#### 4.3.3. Experimental Procedure

The spontaneous play sessions in which the materials defined the task structure and in which verbal instructions played a small part, proved to be most suitable for this group of young subjects. Only one child had to be excluded from the study because she consistently refused to respond.

#### 4.4. QUESTIONS FOR FUTURE RESEARCH

A number of further questions suggest themselves when considering this study. Firstly, the question of whether or not Phase 4 in Sugarman's (1983) account of developments in classification is a necessary and widespread phase, requires further research. Secondly, there is the interesting question of why a structured situation elicited a skill which did not appear spontaneously in this particular group of children. Factors governing performance, the competence which relates to processing input and output of a particular concept (Flavell and Wohlwill, 1969) need to be further investigated and explained. A starting point

could be the response set hypothesis discussed in 4.1.2.

The purpose of this study was to describe the development of object grouping behaviour of a lower social class group and to consider whether findings could be compared with previous studies of middle-class children. The study suggests certain universal trends in conceptual development and some possible areas in which there may be differences. However, it remains for an empirical investigation of class differences to be done. One of the considerations in planning such a study is that in electing to define social class on the basis of income, housing, educational levels and occupational status, one is left with a very gross estimate, one which makes it difficult to trace the behaviour studied to its causes or even to those factors with which it is most closely associated. It has been demonstrated even within the community from which this sample is drawn (Biersteker, 1979) that there is enormous variation within the lower-class category. In addition, Ginsburg (1972) points out that "typical" class-related patterns of response often reflect the performance of no more than fifty percent of the subjects. Isolation of these class-related variables in relation to the development of classification and related concepts would provide the second step in researching this problem. Thirdly, as Bronfenbrenner (1979) has suggested, the processes by which such social class differences are formed could be studied.

Although this study has confirmed that different materials can elicit different forms of a skill, and supports the call for an approach to cognitive development that gives these environmental influences sufficient emphasis (e.g. Fischer, 1978; Furby, 1980), the continued investigation of the effect of every type of material on the expression of each concept would be a daunting and unnecessary task. What seems to be required is that in future studies researchers are more aware of the complex interplay of environmental variables and cognitive skills and consequently make efforts to study performance on cognitive tasks under various conditions before reaching general conclusions about the presence or absence of those competencies.

In conclusion, while the results of the investigation suggest that children from low socio-economic backgrounds show the same general developmental trends in object grouping behaviour, both parts of the study suggest the role of environmental factors in their performance on the grouping tasks. The social class factors lack clear definition and little is known about how they operate; task variables are clearer but these too must interact with social class or cultural variables to influence performance. Research which begins to clarify this picture will have great importance for educational programmes aimed at assisting disadvantaged children and their families to perform in settings in which middle-class values and skills

predominate. It may well be that the present emphasis of many such programmes on teaching logical skills is misplaced and that what is required is an approach which focusses on the skills needed to process task requirements.

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APPENDICES

APPENDIX A: THE ATHLONE ELC SOCIO-ECONOMIC INDEX

APPENDIX B: PRESENTATION ORDERS FOR THE SIX TASKS

APPENDIX C: EXAMPLE OF TRANSCRIBED AND CODED DATA

APPENDIX D: STATISTICAL VALUES FOR ALL COMPUTATIONS  
FOR PART TWO - TASK EFFECTS ON GROUPING  
BEHAVIOUR

APPENDIX ATHE ATHLONE ELC SOCIO-ECONOMIC INDEX

This index was developed on the basis of a survey of 116 Kewtown families done by research staff at the ELC during 1972 (Athlone ELC Research Report No. 1, 1972). Its purpose was to discriminate the different levels within the low income Kewtown community. There were three steps in its development:

(1) Frequency distributions were calculated for:

- weekly income per family member;
- occupational status of head of household  
(white collar; skilled manual; semi-skilled; unskilled; unknown);
- education, in years of schooling, for both parents separately;
- number of persons per room as a measure of degree of overcrowding.

(2) The raw data were converted to scale ratings and an index combining the above was formed. Variables were equally weighted after independent testing. Scale ratings from 1 to 10 were assigned to class intervals in each of the frequency distributions.

(3) Total scores were converted to percentages so that if information was not available on all five variables, a score

could still be computed.

Independent testing confirmed that this socio-economic index successfully discriminated different levels in the low income Kewtown community.

For purposes of this study, it was used to check whether the subjects conformed to the pattern of low income families found in the ELC Family Survey (Biersteker, 1979). The same range of scores on the index was found.

The variables of education, occupational status and overcrowding were all used but the original scale for income was too outdated. Weekly income per family member was therefore calculated on the basis of estimates from the Bureau of Market Research, Unisa (Research Report 105, August 1983).

APPENDIX BPRESENTATION ORDERS FOR THE SIX TASKS

Order 1    Task IV    Blocks/Plates  
             Task III    Triangles/Hexagons  
             Task V     Animals/Furniture  
             Task II    Cylinders/Columns  
             Task VI    Red/Blue Balls  
             Task I     Cars/Eating utensils

Order 2    Task I     Cars/Eating utensils  
             Task II    Cylinders/Columns  
             Task VI    Red/Blue Balls  
             Task III    Triangles/Hexagons  
             Task IV    Blocks/Plates  
             Task V     Animals/Furniture

Order 3    Task VI    Red/Blue Balls  
             Task V     Animals/Furniture  
             Task III    Triangles/Hexagons  
             Task IV    Blocks/Plates  
             Task I     Cars/Eating utensils  
             Task II    Cylinders/Columns

APPENDIX C

EXAMPLE OF TRANSCRIBED AND CODED DATA:

SUBJECT C<sub>5</sub> AGED 33 MONTHS. PRESENTATION ORDER: 3Task I (Cars =  / Eating utensils = 0 )Sequential Action UnitsConstructions1. Contacts <sub>1</sub>2. Drives <sub>2</sub> around and places  
beside <sub>3</sub><sub>2</sub> <sub>3</sub>3. Drives <sub>3</sub> around, parks  
beside <sub>2</sub><sub>2</sub>  
<sub>3</sub>4. Adds <sub>4</sub><sub>2</sub>  
<sub>4</sub> <sub>3</sub>5. Adjusts <sub>3</sub><sub>2</sub>  
<sub>4</sub> <sub>3</sub>6. Lifts 0<sub>1</sub> (cup) and replaces0<sub>1</sub> <sub>2</sub>  
<sub>4</sub> <sub>3</sub>7. Puts 0<sub>2</sub> in 0<sub>1</sub>0<sub>1</sub> <sub>2</sub>  
0<sub>2</sub> <sub>4</sub> <sub>3</sub>



Sequential Action Units

Constructions

15. Re-arranges

- 1
- 2
- 4
- 3

16. Lines  $O_3$  and  $O_2$

$O_3 O_2$

- 1
- 2
- 4
- 3

17. Adds  $O_4$

$O_4 O_3 O_2$

- 1
- 2
- 4
- 3

18. Adds  $O_1$  to  $O_4 O_3 O_2$

$O_1 O_4 O_3 O_2$  (D)

keeps hand on them

- 1
- 2
- 4
- 3

Constructions:

One-class B ( $O, O_3$ ) and C

Two-class A and D

Order successive

Task III: (Triangles =  $\triangle$  / Hexagons =  $\hexagon$ )

Sequential Action Units

Constructions

1. Touches  $\triangle_1$

2. Lifts  $\triangle_1$  and lines up with  
 $\triangle_2$

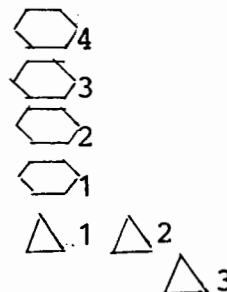
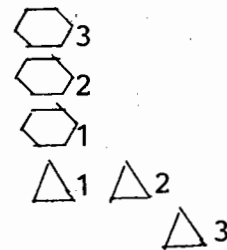
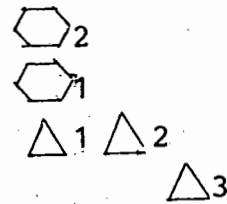
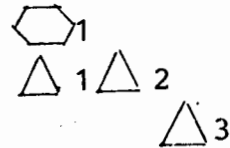
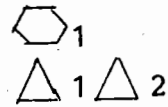
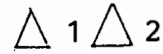
3. Places  $\hexagon_1$  on top

4. Places  $\triangle_3$  next to  
construction

5. Stacks  $\hexagon_2$  on top

6. Stacks  $\hexagon_3$  on top

7. Adds  $\hexagon_4$



Sequential Action Units8. Lines up  $\triangle_4$  at baseConstructions

(A)

Construction:

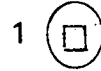
Two-class, mixed order (A)

Task IV: (Blocks = □ / Plates = ○)

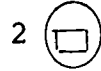
Sequential Action Units

Constructions

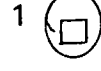
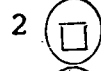
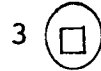
1. Manipulates 1 and places on  
○<sub>1</sub>



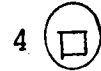
2. Places □<sub>2</sub> on ○<sub>2</sub>



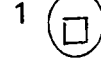
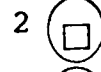
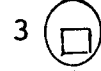
3. Places □<sub>3</sub> on ○<sub>3</sub>



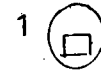
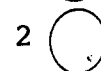
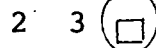
4. Places □<sub>4</sub> on ○<sub>4</sub>



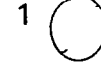
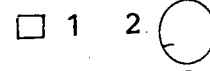
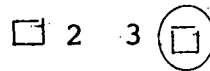
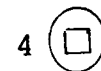
(A)



5. Removes □<sub>2</sub>



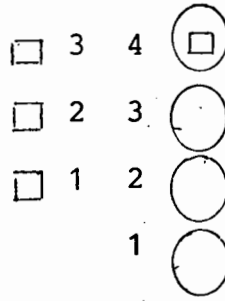
6. Removes □<sub>1</sub>



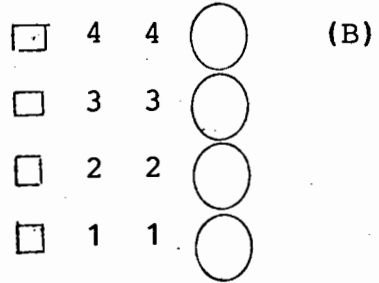
Sequential Action Units

Constructions

7. Removes  3

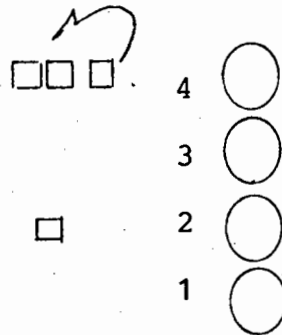


8. Removes  4

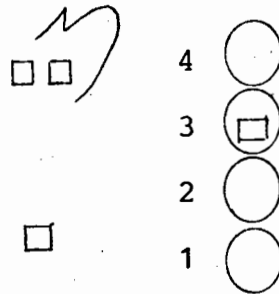


9. Touches  1

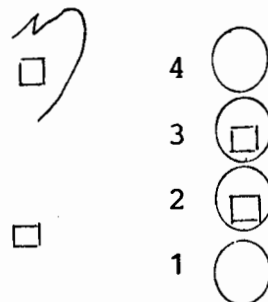
10. Touches and lifts   
(hand)




11. Places  on  3



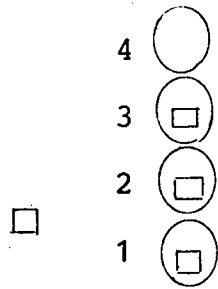
12. Places  on  2




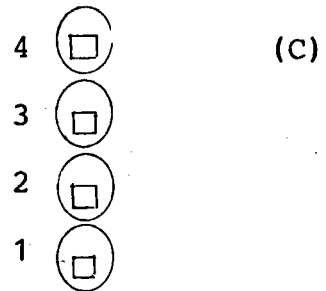
Sequential Action Units

13. Places  on 

Constructions



14. Places  on 




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Constructions:

- Correspondence: A - 4 subunits precise, procedure not integrated
- C - 4 subunits precise, not integrated
- Two-class B - successive, manipulated one class only

APPENDIX D

STATISTICAL VALUES FOR ALL COMPUTATIONS FOR PART TWO: TASK  
EFFECTS ON GROUPING BEHAVIOUR

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1. TASK DIFFERENCESTotal Number of Constructions:

	$\chi_r^2$	df
Whole sample	7,5812	4
Group A	2,75	4
Group B	5,075	4
Group C	3,625	4
Group D	9,3465	4

Percentage Consistent Constructions:

	$\chi_r^2$	df	
Whole sample	7,852	4	$p < .1$
Group A	2,175	4	
Group B	3,6	4	
Group C	2,375	4	
Group D	1,74	4	

Percentage One-class Constructions:

	$\chi_r^2$	df	
Whole sample	8,175	4	$p < .1$
Group A	2,85	4	
Group B	1,019	4	
Group C	8,575	4	
Group D	2,2785	4	

Percentage Two-class Constructions:

	$\chi^2_r$	df
Whole sample	4,24	4
Group A	1,625	4
Group B	7,475	4
Group C	5,675	4
Group D	0,5	4

Percentage of Mixed Constructions:

	$\chi^2_r$	df
Whole sample	1,008	4
Group A	1,625	4
Group B	1,75	4
Group C	,925	4
Group D	1,59	4

Percentage of Geometric/Real Constructions: Wilcoxon

Matched-Pairs Signed-Ranks Test.

Percentage of Consistent N 27 z = 2,198 p = .0143

Percentage of One-class N 28 z = 2,152 p = .0158

Percentage of Two-class N 24 T = 123

2. AGE DIFFERENCES PER TASKPercentage of Mixed Constructions:

	H	df	
Task I	7,8559	3	p < .05
Task II	4,299	3	
Task III	3,258	3	
Task IV	5,258	3	
Task V	7,0668	3	

Percentage One-class Constructions:

	H	df	
Task I	5,7136	3	
Task II	7,402	3	
Task III	3,972	3	
Task IV	10,561	3	$p < .02$
Task V	6,2178	3	

Percentage Two-class Constructions:

	H	df	
Task I	8,14	3	
Task II	11,214	3	$p < .02$
Task III	3,22	3	
Task IV	15,2	3	$p < .01$
Task V	9,8459	3	$p < .02$