UNIVERSITY OF SOUTHAMPTON

PEER INTERACTION : ITS ROLE IN COGNITIVE DEVELOPMENT

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Doctor of Philosophy

by

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ABSTRACT

FACULTY OF SOCIAL SCIENCES

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PEER INTERACTION : ITS ROLE IN COGNITIVE DEVELOPMENT

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In recent years there has been a growing research interest in the social nature of knowledge (e. g. Doise, 1978 ; Vygotsky, 1962). This is also the concern of this thesis which considers the role of social interaction as a facilitator of individual cognitive change. Of particular interest is the impact of exchanges between equals in accordance with early suggestions of Piaget (1926, 1932) concerning the significance of peer interaction for the achievement of operational thinking.

Several investigations have been carried out which demonstrate that children working together in structured situations were individually better able to formulate clear strategies to solve a problem and to generalize their understanding to parallel problems than children working by themselves. A number of influential factors on this process are examined and discussed. These include the structure imposed upon the situation by the experimenter and by the nature of different tasks, the levels of understanding subjects bring to the encounter and the roles they adopt during the encounter. The issue of whether the efficacy of peer interaction is a phenomenon restricted to middle childhood, as suggested by Piaget (1926, 1932), is also examined. Finally, videotaped recordings of interactions revealed that aspects of verbal interaction (e. g. verbal countering of a partner's judgement) were highly predictive of post-test performance. The findings are discussed in terms of the mechanisms through which social exchanges may accomplish individual change in the child's thinking and their implications for both psychological theory and for the practical educational issues of group work in the classroom.

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CHAPTER 1

THE RELATIONSHIP BETWEEN THE 'SOCIAL' AND THE 'COGNITIVE' IN DEVELOPMENTAL PSYCHOLOGY

1.1 INTRODUCTION

Early suggestions of Piaget's (1926, 1932) concerning the significance of peer interaction for the achievement of operational thinking have often been used to support the case for group work in schools. However, Piaget conducted no systematic studies on this topic, his own very influential studies having focussed increasingly on the nature of cognitive development in the individual. In recent years an upsurge of interest in social aspects of cognition has led investigators back to this question . For the first time, principally in the work of Doise and colleagues in Geneva (e. g. Doise, Mugny and Perret-Clermont, 1975 ; Doise and Mugny, 1979), the value of social interaction between children of similar levels of ability has been subjected to careful experimental assessment. These studies have suggested that through interaction in pairs children can master tasks which are beyond either of them individually, and that this mastery carries over into subsequent individual performances. The work carried out for this thesis aimed to examine this phenomenon and to investigate some of the factors which govern the proposed productiveness of interactions.

In Chapter 2 I will specifically focus my attention on the literature concerned with peer interaction and learning. The four chapters following this will set out the experimental work undertaken for this thesis and the final chapter will reflect upon its implications for developmental theory and upon some of its implications for educational practice. In this opening chapter I wish to provide some account of the background to the view that

social, and in particular peer, interactions may play a causal role in the development of understanding. The importance of a child's interactions with his age peers as an influence upon the development of his social behaviour has long been acknowledged (e.g. Parten and Newhall, 1943 ; Campbell, 1964 ; and Hartup, 1970). The idea that peer interaction might have a special part to play in cognitive development also has a long history, but has received little systematic attention from psychologists.

Traditional definitions of psychology have repeatedly emphasised that its object is the individual human subject. This does not mean that psychology has ignored social or environmental influences upon psychological processes, but that such questions have been relegated to specialized compartments of the discipline which have been labelled "social" and "cross-cultural" psychology. This has been clearly demonstrated within developmental psychology where much work concerned with individual development has characterised the social environment in a relatively passive fashion and has focussed its attention on cognitive structures internal to the organism. Work concerned with aspects of social development, on the other hand, has generally placed its emphasis upon the various social cues to which the child must accommodate.

While attempts to unify these two traditions are theoretically problematic much research in recent years, which has been classified under the label of 'social cognition', has reflected an attempt to integrate the areas of social and cognitive developmental psychology. Light (1981) has classified three main research interests of those engaged in the investigation of social cognition. One is the study of the role of the culture in the growth of understanding. Another is research devoted to the study of children's social knowledge. Finally, there are those investigations concerned with the extent to which persons, as

opposed to other inanimate or non-social objects, may be influential in the construction of knowledge which is the primary concern of this thesis. Work in these areas has reflected many researchers dissatisfaction with a dichotomous view of development. Initially, therefore, I wish to consider some evidence pertaining to the relationship between the social and cognitive aspects of development and in particular to research which suggests that the individual and the social should not be considered in isolation but as intricately inter-related.

1.2 THE IMPORTANCE OF CONTEXT

Within developmental psychology there is a growing dissatisfaction with certain aspects of Piagetian theory, notably the idea of "invariant stages of development" - that is, successive systems of mental organisation which differ radically from each other and through which all normal children pass in the same order and at roughly the same rate. There is growing research evidence which suggests that a rigid adherence to these particular aspects of the Piaget tradition may be misleading when applied to assessing the intellectual capacities of children.

Piaget has focused his attention generally upon conceptualizing the structure, organisation and dynamics of the individual's own internally generated structures, paying little attention to the context within which this development occurs. Piaget's concern for structure and his assumption that the growth of knowledge content is subordinated to form is reflected in the kind of research which psychologists concerned with cognitive development have undertaken. Piaget's vastly influential paradigm has frequently portrayed the child as developing in relative social isolation and he has generally exercised a preference for research involving impersonal rather than social objects resulting in an ambiguity regarding the role played by the

social environment in this process of change.

Piaget's account of cognitive development has generally neglected specific aspects of experience because he is seeking developmental universals. He has chosen to focus his work on discovering those aspects of individual cognitions which are the most general such as classification and seriation. The generality of these concepts makes it possible to study their emergence without considering the specific environment in which they develop. However, these universal developments which Piaget discusses do not occur in a vacuum regardless of the extent to which they are self-generated. Individual development, in fact, occurs in very specific social, historical and cultural environments. The central thrust of a great deal of recent work has been a growing recognition of the importance of the social context in influencing the way in which individuals use mental processes. There are now many studies revealing the impact of variations in logically irrelevant features of Piagetian conservation problems. It is not my intention here to provide a full review of this literature (see Neilson and Dockrell, 1982) but to emphasise that much behaviour which has traditionally been viewed as taking place in isolation is in fact influenced by the social and cultural context in which it occurs.

One of the better known of these investigations was the McGarrigle and Donaldson's (1975) study of number conservation. In this investigation they demonstrated that when, in the traditional test situation, an adult deliberately lengthens one of two equal rows of counters a high proportion of children aged four to six years gave non-conserving judgements. However, when the same transformation was brought about accidentally by a "naughty teddy" a large percentage of the subjects judged correctly that the transformation did not alter the fact that the number of counters in each row was the same. They proposed that the difference in

performance in these situations was due to the child's assumption that when an adult asks a question about something, then does something to change the thing being talked about, and then repeats the question, it is a safe bet to assume that the action is relevant to the question. But if the action is made transparently accidental, this assumption is removed and therefore more children reply correctly. A similar argument was proposed by Rose and Blank (1974) who argued that the repetition of the question may lead the child to suppose that his original answer was wrong. They demonstrated that when the first judgement was omitted that children were more likely to give conservation judgements. The point is that, in a situation like the conservation test, the "social logic" of the context - that is, the rules and conventions governing everyday discourse - may take precedence over the "formal logic" of the problem.

The language used during the testing situation also appears to be an important factor in determining children's judgements. For example, Sinha and Walkerdine (1977) devised a variation of Piaget's conservation of liquid test. Children were shown a large toy horse and a small toy dog. Each had in front of it a standard beaker, but the horses contained more liquid than the dog's. The subjects were told that the big horse liked a lot to drink while the small dog only liked a little to drink. The experimenter then poured the dog's drink into a tall, narrow beaker, and the horse's drink into another standard beaker so that the dog's drink was higher in the glass than the horse's. The experimenter then repeated his first statement and then asked the subject to "give the animals their drinks". Seventy per cent of the three and a half and four year olds who were tested succeeded on this test ; none of them was a "conserver" on the traditional Piagetian test.

The authors' proposed that the reason for this lies in

the manner in which the instructions primes up the child to construct particular hypotheses in order to solve the problem. They suggest that children have difficulty with the meaning of the words "same", "different", "more" and "less" which are commonly used in the traditional test situation. These particular relational words have complex meanings. First, two different things are the same as each other, if they look similar. Secondly, there is also an identity sense of "same", for example "I am the same person today as I was yesterday". The child must learn the relationship between these two different senses, in order to select the appropriate one in any particular situation. In the standard conservation task, everything is set up so as to prime up the first sense - that of similarity of appearance. But in fact the task demands that the child should suppress this sense in order to succeed. In the "animals" experiment the relationship between words and actions is different. Because of the use of the imperative "Give the animals their drinks" instead of a question - for example, "Which one has more ?" - it is the child who performs the action not the experimenter. The task focuses on actions rather than a perceptual judgement. In this context the child seems to be able to dismiss the "misleading" perceptual cues as irrelevant to the hypothesis that he or she is forming. The child's understanding of the question in the traditional task may be dependent upon how he interprets the meaning of words as they relate to the immediate situation.

As suggested, the meaning of many words children acquire depends upon context. In making sense of the relationship between the meaning of a word and its context of use, the child is learning the rules of language use which are current in its culture. A study by C. Hill (reported by Sinha and Walkerdine, 1978) attempted to demonstrate this cultural influence. In this investigation he placed a toy lorry on a model road. Children of various ages, and adults, were asked to place a toy car either

in front of or behind the lorry. In some conditions, the lorry faced along the road and in others it faced across.

At all ages, subjects used consistent rules to interpret the task, though at different ages, different rules were used. Variations in performance strategies resulted apparently from the different degrees of knowledge about the properties of vehicles and roads which the subject's possessed. This was particularly evident for some of the oldest children and adults who used more sophisticated strategies called "road user strategies". For example, when the lorry was facing across the road, they would say that it must have come out of a side turning and would place the car at a 90^{o} angle to the lorry, along the road. Hill also observed that individuals from industrial societies when asked to place an object in front of a "non-fronted" object, placed it between themselves and the object. Whereas in some other less developed countries (in this particular case Hausa-speaking West Africans) the tendency is to place the object on the other side of the non-fronted object, that is further away from themselves. These findings reflect the influence of socially learned rules and different cultural experience on the different interpretations that can be put on the meaning of words.

Much of this work (particularly with conservation problems) has been used to suggest that misleading features of context and language in these test situations have resulted in workers underestimating the intellectual capacities of the children with whom they deal. It has been argued that success on such modified presentations reveals the true competence of the child which had been hidden in the standard test situations because of misleading social cues. However, as Light (1981) has pointed out, just as failures in the standard presentation may be viewed as false negatives so also can success on the modified presentations be interpreted as false positives. What does seem clear in this

issue is that older children do appear to be able to disregard the ambiguous contextual elements of these situations better than younger ones. However, the main point that I wish to emphasise is that we cannot arbitrarily separate the problem from the situation in which it is set. We must consider the relationship between the child and the environment in which he is placed and the way in which they interact. The test situations are clearly social in that they involve verbal exchanges and the problem will make sense to the child only to the extent that the context is socially meaningful in that he can relate it to what he already knows. The development of the child and his relationship with the world of objects takes place in situations which are socially defined. For example, when a child plays a simple game like peekaboo, he is learning not only to deal with the appearance and reappearance of objects, but also to take turns. Objects possess significance and meaning only in the activities, routines, and conversations which make up everyday life. In acquiring knowledge about objects, the child is acquiring knowledge of how to use objects and symbols within a culture.

Findings of the kind discussed so far suggest a close relationship between the child's understanding of logical problems and his social and cultural knowledge. From this point of view it may be that we must no longer view development solely as the result of various internal processes in the child nor simply in terms of specific kinds of environmental experiences but in terms of the interactions between the two. Rather than stressing the opposition between biology and society we must emphasise their inter-relationship. This is the next issue to which I wish to turn.

1.3 THE DICHOTOMY BETWEEN THE SOCIAL AND THE PHYSICAL

From its very inception, psychology has sought

explanations for patterns of human behaviour by invoking, on the one hand unversal laws governing mental processes and, on the other hand differences between individuals or groups in their abilities to use these. There have been competing explanations of the origins of such differences. Some psychologists have looked to biological factors, including genetically transmitted characteristics. Others have looked at differences in the ways in which each culture constructs its own interpretation of the world, and suggested that such differences may affect the typical patterns of deployment of basic mental processes. But hitherto, all these explanations have remained trapped in an opposition between nature and nurture, and individual and society. However, Richards (1977) has argued that the way we tend to conceptualize the interaction of the social and the biological is based on the fallacious assumption that there are variables that are biological and those that are social, and these can be specified and extracted. Richard's view is that even the biological is social in that natural selection operates on phenotypes and not gen otypes and

> "phenotypes results from a process of development which is dependent on a social world as well as on a physical environment" (p.189).

Thus the biological is not a realm immune from the social. Similarly the social factors in development may operate through a biological adaption. Other authors (e.g. Broughton, 1978 ; and Mischel, 1974) have similarly argued that the social versus physical distinction is artificial.

There has been a parallel dispute in psychology concerning the dichotomy between social and physical objects of knowledge. Psychology has frequently treated the realms

of social development and cognitive development separately. Thus, for example, Kuhn (1978) characterised studies of social and cognitive development as arising within different theoretical perspectives which share little in common. Social development largely being studied within a behaviouristic or 'mechanistic' view of the world being primarily concerned with external environmental stimuli as determinants of behaviour. While the majority of work in cognitive development has entailed an 'organismic' view of the child and has focused its attention on processes internal to the organism and largely ignored the complex environment within which development takes place.

While Kuhn characterised the Piagetian tradition as firmly founded in the latter category, Piaget did argue that the logico-mathematical structures which he described were generalisable to both the physical and social world. The child's developing view of the physical universe being paralleled in his conception of self and social objects.

In fact, Piaget not only argued that the social and physical interpenetrate he, at least in his early writings (e.g. Piaget, 1932), accorded a particularly important and causal role to social interactions in the development of operational thought. Damon (1979) following this line of argument pointed out that interactions with others may have unique characteristics that demand a particular kind of cognitive-structural development in the child. He continues that :

> "Unlike all other components of the world, other people have the capability to establish mutually intentional relations with the subject. Such relations are composed of an ongoing series of interactions in the course of which the subject shares perspectives and coordinates actions and reactions with the other. It is this mutuality of conduct and communication that distinguishes social from merely physical events, and that engenders a special sort of understanding". (p. 208).

While I agree that social interactions have unique characteristics which may make their role in the child's development particularly important I would take issue with Damon's criterion for distinguishing social from physical events. Damon argued that social interaction is typified by mutual intentionality, which is absent in interactions with physical objects where intentionality is one sided. The problem is clearly how do we identify actions as intentional. As Butterworth (1982) has pointed out there has been several accounts of the emergence of intentional action (e.g. Bruer and Lyons, 1968 ; Bower et al, 1970 ; and Frye, 1980) which have varied largely due to differing definitions of intentionality itself. He suggests that there is a danger of the problems of dichotomising physical and social objects being simply transferred to defining intentionality and suggests "reciprocity" as a better criterion for establishing whether or not an action can be categorised as social. Reciprocity is dependent upon some degree of awareness of mutual relationship and requires a conscious recognition of a distinction between self and other without invoking the necessity for intention. If this criterion is accepted then some relations may be regarded as intrinsically social, and even the young infant may be attributed with social relations at an age prior to that suggested by Piaget. These relations may be formative in his developing views of the world even though the young infant may not possess the concepts or the self knowledge to define these relationships as such.

1.4 THE INFANT AS A SOCIAL BEING

Piaget viewed the infant as beginning life unable to differentiate between "self" and "not self" with the child's experience of himself being the only reality. He portrayed the infant as egocentric, living in a private world which was an extension of himself and being unable to attribute or take account of the perspectives of others. However, recent studies have suggested that such a view may be mistaken, and suggest that even

very young babies are aware that others have points of view, although this does not imply that they can necessarily specify what that view is.

Some of the most important sources of such evidence stems from research into early infancy which gained much of its initial impetus from biology. Bower (1974) in a series of experiments, demonstrated that Piaget's view of the baby as an extremely limited biological organism, unable to conceive that objects are permanent and assimilating all events to their own point of view, stands in need of substantial revision. He has shown, for example, that a two month old baby can follow a moving object with its eyes, and can even "predict" the reappearance of the object after it has passed behind a screen. Infants can react appropriately not only to moving objects - by grasping them, blinking their eyes or whatever, but also to human faces. The baby can rearrange his facial expression to match another's - though unable to see his own expression.

Many workers (e.g. Richards, 1971 ; Condon and Sanders, 1974 ; Newson 1974 ; Schaffer, 1974 ; Stern, 1974 ; and Trevarthen, 1975) have described detailed sequences of interaction in which mothers are sensitively phasing their stimulation of the infant to produce complex and meaningful patterns of interdependent behaviour. Filmed records of mothers playing with babies reveals a very high degree of coordination of behaviour. The baby is capable not only of matching and imitating the mother's actions, gestures and expressions, but also of timing his own responses so that they sequentially alternate with those of the other. Where Piaget sees the baby interacting with either an object or a person, in much the same way, in each case, Trevarthen (1975) has demonstrated the existence of a three-way (triadic) interaction between mother, child and the object they are playing with.

Watson (1972) suggested that consistent and repetitive interaction with precise response contingent stimulation may amount to the generic definition of social stimulation for the young infant. This idea, that contingent responding initiates the social behaviour of the infant, has its counterpart in the finding of Lewis and Goldberg (1969) that by twelve weeks of age those infants whose mothers were most responsive to their demands and vocalizations were already more efficient in the acquisition of new "schemata". The available evidence makes it possible to construct a very strong case for the proposition that the kind of maternal behaviour that is labelled "social" has the major characteristic of providing the baby with experiences of an environment which responds contingently to his cues, states and sensations. Furthermore, early and sustained exposure to such contingent responding seems to be fundamental to both social and cognitive development. This process does not, of course, imply that the baby is conscious of his own desires, or of his ability to communicate his needs. The mother is constantly monitoring her baby. The baby is not capable of monitoring his mother's behaviour in the same way, yet he is none the less constantly modifying his mother's response patterns to meet his needs. In reviewing such evidence Newson (1974) concluded that early socialization results from a culturally competent individual treating the infant's behaviour as socially meaningful. He emphasised the importance of social mediation in conveying meaning which he sees as being seriously underrated by Piaget and many other developmental theorists.

In fact as previously pointed out the role of social mediation in the development of knowledge was stressed by Piaget in his early writing although

only specifically in relation to the breakdown of egocentrism sometime during middle childhood. It is to this issue that I now wish to turn my attention. However, prior to a consideration of the mechanisms which Piaget saw as underlying this change, I wish to devote some space to the concept of egocentrism which is central to this aspect of Piaget's theory.

1.5 EGOCENTRISM

Egocentrism reflects Piaget's attempt to clarify the relationships of social and invidual factors in early and middle childhood. The importance that the concept of egocentrism has assumed in the explanations of development is reflected in the large body of research directed towards establishing the nature of egocentricity, the stages during which it diminishes and the consequences of change.

Egocentrism generally refers to the child being embedded in his own point of view. According to Piaget the child initially centres on his own actions and his own points of view in his interactions with the world about him. The basic idea is that the child, until sometime during middle childhood, tends to concentrate his attention on one dimension either perceptually or intellectually and is unable to understand and take account of the perspectives of others. Egocentrism, it is believed, is a rather generalised inability reflected in communication skills (such as telling a story to another, or adjusting one's speech appropriately), in moral judgement, in judging perspective, in logical reasoning and in taking the role of others. Each of these separate abilities is believed to be dependent on eventual decentration, that is on moving away from a self-dominated schema to a socio-centric or allocentric perspective. Thus egocentrism reflects the absence of both social reciprocity and intellectual reversibility. Until they develop the young child is seen, as a result of the general lack of sophistication in his intellectual

operations, to live in a world which is an extension of himself.

Piaget thus invoked egocentrism as an explanation of a wide variety of behaviours during early childhood and used the concept to define the relationship between social behaviour and individual cognitive development in this period. Piaget described this phase of the child's development as 'preoperational' occurring after the end of the sensorimotor period (up to about two years) and before the development of concrete operations (at about seven years of age). Preoperational thought is characterised by syncretism, that is to say, the tendency to assimilate any features of reality whatsoever into undifferentiated intellectual schemata. Furthermore, the child's egocentrism results in a lack of concern with conceptually integrating objects within a cause and effect framework, the child being indifferent to any need to unite propositions by logical implication. The child tends simply to link (juxtapose) one thought element to another, rather than to link them causally.

During this period the child centres his attention on only one aspect of a situation thus, for example, failing to grasp the invariance of physical properties undergoing transformation. Only later does he regulate his thinking by paying attention to aspects undergoing reciprocal changes. Thus, initially, in the classic conservation of quantity situation, when the child is presented with two identical glasses filled with liquid to the same height the child will agree that they contain the same amount. If the contents of one glass are then poured into a tall narrow glass and the child asked whether the amounts of liquid are still the same, he will usually deny this. The child's judgement is said to be focussed upon only one perceptual element, for example liquid level, which he uses as the decisive criterion. Only later does the child realise that every change in height is compensated by a change in width, which amounts to saying (in Piagetian terminology)

that the child decentres his thinking, and is therefore able to think about more than one aspect of the situation at a time. However, as was pointed out earlier the cause of the child's failure to conserve may be due to several other features of the test situation and it may be that Piaget underestimated the ability of the preoperational child in this respect.

Similarly Piaget also viewed the egocentric child as limited in his social skills being unable to appreciate the points of view of other people, and he saw this as reflected in the child's language. Piaget's view of language is important in this respect. He saw language as a set of conventional signifiers existing in a culture, which are either known or unknown. Piaget claimed that language is irrelevant to the development of cognitive operations at this age, viewing it simply as a symptom of the child's underlying intellectual orientation and thus reflecting his intellectual structures. While language may assist the selection, storage and retrieval of environmental information, it cannot aid in its co-ordination. Co-ordination, at least in the phase of concrete operations, presupposes the development, by assimilation and accommodation, of the relevant intellectual structures. This is not to say that language may not make an important contribution to the structures of the phase of formal operations (where we may expect symbolism to play a more important role) but the argument is that language is insufficient to explain the initial formation of operations.

Piaget classified children's utterances as either egocentric or socialized. He maintained that the child's speech at first contains a high proportion of egocentric reference, becoming more socially directed (or sociocentric) only after the age of seven years. Egocentric speech may occur when the child is alone or in the presence of others and is characterised by a lack of

communicative intent. The child makes no attempt to consider the role of his listener, failing to adapt his message to the specific needs of his audience. Children may engage in long solioquies or monologues without waiting for any reaction from a listener or they may pick up a phrase uttered by another and play with it without actually responding to it. As Piaget described it :

> "The conversations among young children remain rudimentary and linked to material action itself. Until seven years of age children scarcely know how to have discussions among themselves and confine themselves to making contradictory affirmations. When they try to furnish explanations to others, they are not really able to put themselves in the place of the other person, who does not know what they are talking about ; they speak as though they were talking to themselves". (Piaget, 1967, p. 20).

Only later does Piaget view the child as developing socialized speech in which there is an indication of genuine communicative orientation towards the listener. During the period from two to seven years the transition between these two forms of thought is seen as developing with the second form gradually gaining precedence over the former. The proportion of childish utterances that may be classified as egocentric slowly declining.

Piaget's account has met with considerable oppo sition, particularly from investigators who objected that the amount of egocentrism in the child's language had been exaggerated by Piaget. The most heated critiques of the concepts of egocentrism revolve around Piaget's (1926) claim that the listener "is expected neither to attend nor to understand" (p. 33). Some critics, particularly Vygotsky (1962) have interpreted this to mean that children do not intend to communicate at all, they are asocial beings who speak

simply to hear themselves talk. Vygotsky pointed out that the "internal speech" of adults is essentially egocentric, so egocentrism does not simply atrophy with age as Piaget suggests. Piaget would object that the intellectual make-up of the adult is so different from that of the child that it would be misleading to apply the term "egocentric" to adult thought. However, Vygotsky's point suggests that we may distinguish two modes of understanding in adults as against one in children and suggests that the mechanism of internal speech begins to stabilize at around seven years of age. Vygotsky went to great pains to demonstrate, for example, that child "monologues" decrease greatly in frequency and length when no listeners are present and when the listener is deaf or otherwise unresponsive. According to Vygotsky all speech is social in intent inasmuch as it is intended as a form of conduct with others, but is not necessarily communicative. Vygotsky's scheme therefore proposes that the development of speech is from social to egocentric rather than the other way. Egocentric speech, in Vygotsky's formulation, arises when the child starts conversing with himself. Piaget (1962) clarified what had been regarded as a classic debate between the two authors, by explaining that the egocentric child may indeed be very socially motivated during most of his speech. He is egocentric only insofar as he is unable to adapt his speech successfully to his intended listener.

Although Piaget insisted in his 1962 rejoinder that young children are indeed socially motivated, he made a rather strong claim that children are not capable of a truly empathetic understanding of others until almost 13 years of age. This claim should be restricted to some sophisticated kinds of insights into the motives and feelings of others, since younger children are not totally incapable of insight or compassion. Borke (1971), for example, has demonstrated convincingly that small children (3 to 5 years) can recognise the facial expressions of others as "happy", "sad",

"afraid", and "angry". Garvey and Hogan (1973) examined 15-minute interactions between eighteen dyads of $3\frac{1}{2}$-5 year olds. They learned that although the phenomena described by Piaget as "egocentric speech" are present, children also engage in a great deal of answering and questioning about motives and so forth. Garvey and Hogan recall that in a separate work on the development of causality, Piaget (1932) himself states that children in the "precausal" era around 4 years of age tend to ask a great many questions about psychological motives. Finally, Borke (1972) offers some particularly eloquent examples of social insight in children from $1\frac{1}{2}$ to 3 years of age.

To conclude, no one, including Piaget, ever intended to suggest that the egocentric child has no social communicative goals at all, nor that he is entirely incapable of insight into the feelings and reactions of others. However, it does appear that Piaget may have underestimated the ability of young children to predict the perspective of others and accordingly to tailor their communication, particularly in instances where the content is matched to the child's level of understanding. As a result he may have underestimated the importance of social relations throughout early childhood as was also suggested by the previously discussed work with infants which implied a close link between the child's interactions with its mother and its developing knowledge of the world about him.

However, in his consideration of egocentrism a widely ignored feature of Piaget's theory of cognitive development has been his insistence on the role of social interaction in the process of developmental change. Social decentration achieved through social experience being viewed as bringing intellectual decentration along also.

Piaget's early writings in this area are of central importance to the theme of this thesis and to its particular emphasis on peer relations in cognitive development. As a result the following section will be devoted to an examination of this aspect of Piaget's theory.

1.6 SYMMETRICAL AND ASYMMETRICAL RELATIONS AND THE BREAKDOWN OF EGOCENTRISM

Piaget (1932) defined two broad stages of moral judgement subsequent to mere obedience to command. The first stage is subjection to another's law. Rules are seen as sacred, moral wrongness is clearly defined and values absolute. The second autonomous stage develops later. In this stage the group, not parents or custom, act as the source of authority. Rules of conduct are products of group agreement and are therefore flexible. Morality is relative, intention not outcome the important variable in making judgements. Piaget has identified two forms of social relations, those of constraint and of co-operation, associated with these different levels of morality. Relations of constraint arise from relations of authority and unilateral respect which develop from the child's view of adults generally and his parents in particular.

> "For in virtue of his very respect, the young child attributes to his parents the moral and intellectual qualities which define his idea of perfection. The adult is omniscent, omnipresent, just and good, the source both of the uniformities of nature and of the laws morality". (Piaget, 1932, p. 380).

Piaget characterized adult-child interactions as oriented to maintaining the parent's leadership and the child's obedience in a legitimate fashion and thought that the child's acceptance of adult authority interfered with his ability to develop independent thought.

Perhaps this was a true reflection of the authoritarian European families which Piaget observed. While it is usually true that final authority does indeed rest with the adult in Western families, there are clearly many family situations where exchange of

ideas occurs and where a child is taught to think through discussion and argument. Hess and Shipman's study (described in Flavell, 1968), for example, of parents explaining to their children how to solve a given problem shows how successful a 'critical thinking' approach can be. Clearly children may establish friendships with adults and authority relations with their peers with each type of social relation still preserving its own special characteristics regardless of the participants. However, Piaget generally characterized the second form of social relations, those of co-operation, as arising between peers. He characterized interactions between peers as more symmetrical where perspectives are shared and actions more likely to be co-ordinated in order to maintain companionship and affection. Rules that arise from these relations are deep rooted and form the basis of autonomous rationality :

> "alongside of .... 'unilateral respect', we have claimed to distinguish a 'mutual' respect towards which the individual tends when he enters into relation with his equals ..... the rule is now subjected to the laws of reciprocity, it is these same rules, rational in their essence, that will become the true norms of morality. Henceforward reason will be free to lay down its plan of action in so far as it remains rational, that is to say, in so far as the individual can adopt a perspective such that other perspectives will accord with it. Thus out of anomy and heteronomy, autonomy emerges victorious". (Piaget, 1932, p. 387/388).

Furthermore, it is clear that the mechanism which Piaget held responsible for the development of a rational morality is exactly the same as that which he thought engendered rationality in general.

> "It is only through contact with the judgements and evaluations of others that this intellectual /.....

> and affective anomy will gradually lead to the pressure of collective logical and moral laws".
> (Piaget, 1932, p.408) .

It was in this connection that Piaget suggested a critical role for the child's interactions with his peers. He argued that co-operation alone can lead to autonomy. The mutual control inherent in such social encounters suppresses both the "spontaneous conviction that characterises egocentrism and the blind faith of adult authority". He argued that adult-child relations, being dependent upon authority were unable to aid the development of operational structures :

> "The relations of constraint and unilateral respect which are spontaneously established between child and adult contribute to the formation of a first type of logical and moral control. But this control is insufficient of itself to eliminate childish egocentrism".
> (Piaget, 1932, p.408).

Piaget clearly indicated that the mechanism through which he regarded the child as freeing himself from egocentrism was peer interaction. Somehow, contact and conflict with others was held to push the child's development by forcing him to confront and restructure his own concepts and percepts as they were revealed in relation to those of other children. Only with his peers, Piaget argued could the child begin to resolve the apparent contradictions between different viewpoints since :

> "Criticism is born of discussion, and discussion is only possible among equals : cooperation alone will therefore accomplish what intellectual constraint failed to bring about". (Piaget, 1932, p.409).

Both morality and logic were seen to develop within the spontaneous

give and take, the interplay of thought and action, which takes place in peer interaction. Particular emphasis was given to the child's arguments and conflicts with other children by which he gradually came to re-examine his own concepts and viewpoints and by so doing gradually rid himself of egocentrism.

However Piaget's emphasis on child-child interactions as a major facilitator of cognitive growth is not reflected in his later writings. In 1950 when he confronts the same question of whether social co-operation is internalized in the individual compelling him to group his actions in operational systems, he also posits the opposite possibility that operational development in the individual may be the precursor to his ability to co-operate with others. He concludes that operational

> "equilibrium could not be considered either as a result of individual thought alone or as an exclusively social product ; internal operational activity and external cooperation are merely .... two complementary aspects of one and the same whole, since the equilibrium of the one depends on that of the other".
>
> (Piaget, 1950, p.166).

and again Piaget (1967, p.40/41) says :

> "One could then say that reflection is internalized social discussion .... This view in accordance with the general rule that one always ends by applying oneself behaviour acquired from others. Contrariwise, socialized discussion might also be described as externalized reflection. Since all human conduct is both social and individual, this problem like all analogous questions, comes back to whether the chicken appears before the egg or the egg before the chicken".

Clearly Piaget is no longer attributing a primary and independent causal role to social experience in individual cognitive development, rather the question is treated as inappropriate on the grounds that the distinction between the social and the individual is artificial since they are two aspects of a single reality.

In his later work, Piaget evidently does not categorically deny any relationship between social interaction and cognitive development. However, his own conceptualization of the mechanisms underlying the process of developmental change have been probabilistic in nature. He suggests that each individual at a given developmental level literally constructs each higher stage as a result of discrepant feedback produced as a result of his actions which reflects his existing stage. Each new stage appears because it is the most probable equilibrium to emerge from disequilibria encountered at the lower stage. Thus a pre-operational child will initially centre on one obvious attribute of a task. In a situation where there is extreme contrast between two attributes there is a fairly high probability that he may on another occasion, centre on another attribute. If he is frequently exposed to this discrepancy there is a high probability that he may eventually coordinate both attributes. As Piaget describes it :

> "Since these displacements of the system are activities of the subject, and since each of these activities consists of correcting the one immediately preceding it, equilibrium becomes a sequence of self-regulation whose retroactive processes finally result in reversibility. The latter then goes beyond simple probability to attain logical necessity".
>
> (Piaget, 1970, p. 78).

In Piaget's system each stage "becomes more probable not a priori, but as a function of the present situation, or of the one immediately proceding it" (Piaget, 1970, p. 225).

Piaget's later view reflects little concern with questions of the impact of particular kinds of experience on cognitive development. Such a position has resulted in some confusion concerning the mechanisms underlying cognitive change since it fails to adequately examine the factors prompting that change. As a result several authors have expressed their dissatisfaction with this position. Barker and Newson (1979), for example, have suggested that Piaget's concern with epistemological questions has made his primary concern the description and analysis of the structural aspects of thought. However, they acknowledge that psychologists "cannot be satisfied with philosophical theory and are lead to ask different sorts of questions" (p. 241). Psychologists must also be concerned with an examination of which experiences facilitate changes in cognitive structures. Clearly an adequate psychological theory of cognitive development must provide an indication of the factors prompting that development and of the processes involved in it. Thus, Smedslund (1966b) and more recently Damon (1979) have advocated a return to Piaget's early emphasis on cooperation and conflict between peers as an instigator of cognitive change.

In the next chapter I will consider work which has suggested that an analysis of the interactions between peers may provide valuable information concerning some possible mechanisms by which concepts evolve. In recent years several authors have taken up the examination of this issue. Investigations of the impact of child-child interactions upon cognitive development have become more numerous, with some authors specifically addressing the question of whether and how inter-individual conflict may be a precursor of cognitive gain in the individual. I propose to examine the evidence for this and other suggested mechanisms which may mediate between social interactions and cognitive development in the following chapter.

CHAPTER 2

A REVIEW OF RESEARCH CONSIDERING CHILD-CHILD INTERACTIONS AS ONE POSSIBLE MEANS OF INSTIGATING COGNITIVE DEVELOPMENT

2.1 INTRODUCTION

In this chapter I will review those studies which have specifically focussed their attention upon the relationship between peer interaction and cognitive development. I shall examine the different theoretical contexts from which this research has evolved and how these reflect the nature of the investigations undertaken. Consideration will be given to the limitations that the differing theoretical perspectives have imposed upon studies of this kind. Finally, I shall evaluate the mechanisms suggested by researchers as mediating between peer interaction and cognitive growth in the light of the existing evidence.

2.2 EXPERIMENTAL STUDIES

One empirical approach to the study of the relationship between peer interaction and cognitive development has involved long-term correlational studies. These have been designed to test the extent to which dramatically different social environments can accelerate or retard cognitive development. It has been hypothesized that environments which provide the child with frequent opportunities to interact with peers will produce more rapid cognitive growth than those in which peer interactions are less frequent, since it is only during such encounters that children are forced to come to grips with differing viewpoints, as opposed to submissively accepting the position of a dominant adult. Hollos and Cowan (1973) studied the effects of social isolation on the development of logical operations and role taking abilities. Norwegian children from towns, small

villages and remote farms took part in the investigation. They found that farm children, the most socially isolated, received relatively low scores on role-taking tests but performed as well or better than village or town children on logical operations. Hollos (1975) undertook an almost identical follow-up study set in rural Hungary. The results corroborated the findings of the earlier study and gave support to a threshold hypothesis which suggests that a basic amount of social experience is necessary for cognitive development, but that further experiences of this kind do not relate to differential skill.

West (1974) argued that Hollos and Cowan's threshold of verbal stimulation hypothesis was not adequately tested by their design because it did not furnish a sufficient number of levels of early peer interaction. Comparing the role taking performance of Israeli boys from Kibbutz, moshav and city settings she found no difference in skill. However, Nahir and Yussen (1977) using two communicative role taking tasks found that children from a Kibbutz were better able to decenter in the formulation of a novel message to a listener and to differentiate better between a child and an adult listener when producing a message, than children from a city setting. Nahir and Yussen attempted to account for these discrepant findings in terms of the different nature of the role taking tasks being used. West predominantly used perceptual role-taking problems while Nahir and Yussen used communicative problems.

Apart from their somewhat inconsistent results, the main problem with such studies is that these different social environments clearly differ in a host of ways, and not simply in the amount of opportunity for peer interaction. An obvious way of overcoming such limitations is via experimental investigation of the short-term effects on problem solving of exposure to different

social experiences. Specific attention to peer interaction as one possible social experience facilitating cognitive growth is a recent development, and it will be necessary to provide some background before focussing on investigations concerned with this issue. Research in this area has been founded on two historical antecedents derived from different traditions in psychology, which have been engaged predominantly with different aspects of development. One is the Piagetian tradition of cognitive development, while the other is the behaviouristic tradition which has been influential in the study of social behaviour. Both have been instrumental in determining the experimental paradigms and theoretical orientations of researchers and my examination of this area of study will, therefore, be prefaced by a consideration of the influence of these different theoretical positions.

2.3 THE ROLE OF TRAINING STUDIES IN THE INVESTIGATION OF COGNITIVE CHANGE

The technique used to study the Piagetian equilibration model as an exploratory mechanism for the transition between his successive stages of development has tended to be the training study. Nearly all of these have focussed on the transition from pre-operational to concrete operational thought and typically upon the attainment of four first order conservations, namely number, length, substance and weight. It is important to examine these studies in some detail since they demonstrate some critical problems in the use of these tasks, which have frequently been employed by researchers engaged in the study of peer interaction. Training studies have generally involved an assessment of change as a result of various short-term intervention procedures. They have been carried out by Piagetians and their critics alike and their primary intent appears to be a discovery of those experiences facilitative of the development of the conservation concept, with the implicit

assumption that such factors have at least close analogues in the natural environment. However, since Piaget (1957, 1970) has made it clear that, in his view, reorganization of cognitive structure does not occur simply as a result of any specific experience but as a result of an interaction between experience and the child's existing cognitive structure, the use of training studies to explore transition, at first, appears paradoxical. Piaget has rejected any important role for learning interventions in the acquisition of operational thinking, such experiences producing "either very little change in logical thinking or a striking momentary change with no real comprehension" (Piaget, 1970, p. 714). Piaget has emphasised that cognitive progress will only result when critical matches of experience and cognitive structure occur. Thus, Piaget's followers have aimed at devising optimal situations for encounters with the environment in which experiences would closely map onto the subjects current mental structures in the hope of illuminating the process of transition during development.

There appears to have been little consensus among researchers regarding which experiences are crucial to the formation of the conservation concept. This has resulted in the use of a wide diversity of learning techniques by different investigators, which have been broadly classified into five categories by Kuhn (1974). One approach is based upon the assumption that subjects fail to conserve because of misleading factors, (perceptual or semantic), present in the test situation, and attempts to focus the subject's attention on the relevant cue. Another approach entails giving the subject relevant and specific information that is necessary for a judgement of conservation. Others believe that a child who attains conservation learns a verbal principle or rule and attempt to teach rules pertaining to the invariance of objects through perceptual transformations. An alternative view maintains that there are certain cognitive operations involved in a conservation

judgement and have attempted to train primarily the operations of reversibility and compensation. Finally, some researchers have attempted to induce structural change by presenting feedback to the subject that is discrepant with his position. This latter view is parallel to Piaget's proposal that some internal disequilibrium may in turn lead to cognitive reorganization and is a precursor to the attempts to induce this disequilibrium socially.

Brown and Desforges (1979) examined the implications for the Piagetian's specifications for a successful training study from this body of research. However, they found that as these specifications take the Piagetian theory for granted, many of the claims are untestable, not made sufficiently clear, or the criteria for assessment are open to dispute. Piagetians have generally considered that such research should illuminate the process of change, while other researchers have primarily been concerned with the quantity of change and have attempted to disprove Piaget's contention that the attainment of conservation reflects an underlying cognitive reorganization by demonstrating that conservation can be learned or speeded up.

The question of whether the attainment of conservation can be speed ed up has been approached by many authors. In an early review of training studies Flavell (1963) concluded that the training of Piagetian concepts in the laboratory was surprisingly unsuccessful. Ho wever, later studies have had far greater success resulting in Flavell repudiating his early position and stating that :

> "few on either side of the Atlantic would now maintain that one cannot by any pedagogic means measurably spur, solidify, or otherwise further the child's concrete operational progress".
> (Flavell and Hill, 1969, p.19).

In a later review Brainerd and Allen (1971) concluded

that there is sufficient evidence to imply that conservation of number (e.g. Beilin, 1965 ; Gelman, 1969 ; Gruen, 1965 ; Rothenberg and Orst, 1969 ; Wallach and Spratt, 1964 ; Wallach, Wall and Anderson, 1967 ; Winer, 1968), of length (e.g. Beilin, 1965 ; Gelman, 1969 ; Gruen, 1965 ; Kingsley and Hall, 1967 ; and Murray, 1968), of substance, (e.g. Briston, 1966 ; Smedslund, 1961 , 1966a), and of weight, (Kingsley, and Hall, 1967 ; Sjoberg, Hoijer and Olsson, 1970 ; Smith, 1968), can be accelerated by appropriate short-term training procedures. They further concluded that all successful studies include in the training presentation a demonstration of reversibility in verbal or visual form. However, any interpretation of these findings remain somewhat ambiguous due to the differing criteria that authors have employed to infer that a conservation judgement is not only given but understood. Kuhn (1974) has criticised the review by Brainerd and Allen on the basis that their sole criterion for assessing the success of a training study was statistical significance between the performance of the control and experimental groups at post-test, on whatever index of conservation the experimenters' employed. It is clear that the criteria problem is a critical one. Piagetians have frequently dismissed the findings of their opponents on the basis that 'true' conservation has not been demonstrated because a full battery of criteria tests have not been carried out. The Piagetians have established their criteria in a number of texts (Inhelder and Sinclair, 1969 ; Inhelder, Sinclair and Bovet, 1974 ; Piaget , 1970) and they can generally be classified into four categories. A subject who is classified as a conserver should be able to ; (a) give an adequate explanation of his conservation judgement ;
(b) reproduce this response at any time in the future ;
(c) generalize the response to related but non-trained material, and
(d) he should be able to resist a nonconservation counter suggestion. However, the assessment of any one of these criteria is fraught with difficulties.

It has been proposed that a conservation judgement should

be accompanied by an explanation since a judgement alone does not constitute a sufficiently demanding evaluation of the conservation concept. However, Brainerd (1973) has pointed to the assertion by Piaget that language is dependent upon operativity such that a cognitive operation may develop prior to the individual being able to express that operation verbally. Thus he argued that explanations were an inappropriate criterion since some subjects may possess the cognitive operation being assessed but fail a test that requires their verbal expression, resulting in the probability of type II errors. However, Kuhn (1974) has pointed out that without an explanation being demanded a subject is left simply with a choice between two alternatives and may make the correct choice for "idiosyncratic or extraneous reasons", resulting in the possibility of type I errors. Even if one accepts the necessity for explanations there still remains a critical problem. Most training methods entail, as an intrinsic part of their make-up, the presentation of one or more conservation explanations either implicity or in the form of explicit verbal rules. Accordingly the repetition of such explanations cannot be regarded as an adequate index of the subject's understanding of the principle of conservation. Thus, an appropriate explanation may be seen as a necessary but not sufficient criterion to imply an operational response.

The second criterion is that a newly acquired operation should be lasting, as it is assumed to be for natural conservers. However, the re-testing of an operation at a later date results in problems of establishing the actual role of the training experience in determining this latter performance, since the natural process of development will also be influential upon outcome. Furthermore, as Kuhn (1974) has pointed out, a subject may repeat his initial performance on a conservation task, at a later date, because he finds himself in the same situation and associates certain behaviours as desired or appropriate for that situation. Thus, the

subject could, once again, produce a correct judgement in the absence of any necessary understanding of the conservation concept.

The requirement that operations should generalize to related materials is based upon Piaget's "structure d'ensemble" view of development. Piaget has suggested that each stage of development is marked by a whole constellation of behavioural acquisitions. The generalization criterion is critical, since if a subject makes correct responses to non-trained items it seems evident that he must have acquired something more than a set of specific behaviours. However, it is well established that the behaviours thought to reflect Piaget's stage of concrete operations do not emerge synchronously but emerge gradually over a period of several years. Gagne (1965, 1968) argued that, since the development of the conservations of number, length, mass, weight area etc. take place at different times, this whole criterion is unreasonable. Conservation for him represents the end point in the acquisition of a long sequence of skills, rules and concepts which are only progressively mastered. For those who accept generalization as a valid criterion then the crucial question becomes how much generalization to non-trained items should we expect. Unfortunately there has been no satisfactory answer to this question and different researchers have adopted different indices of the amount of generalization required to infer structural change.

The final criterion is based upon the contention that a subject who has genuinely achieved an understanding of conservation should be resistant to countersuggestions of non-conservation. Underlying this proposal is the assumption that "natural"conservers are themselves resistant to these experiences. However, a number of investigations have found that "natural" conservers exposed to extinction and surprise paradigms have later

shown some evidence of nonconservation response (e.g. Miller, 1971, 1973 ; Miller, Schwartz and Stewart, 1973 ; Smedslund, 1961 II). Thus, yielding to countersuggestion cannot, by itself, be accepted as a valid indicator that conservation has or has not been achieved.

It is unlikely that this criterion problem will be resolved until we have more precise knowledge about natural patterns of development and cognitive growth, and several authors have therefore emphasised the need for longitudinal studies (Brown and Desforges, 1979 ; Kuhn, 1974). At present the most trustworthy, although still unsatisfactory, method for assessing performance on a conservation task is to elicit as wide a variety of verbal and non-verbal responses as possible. Thus, when attempting to assess claims for the development of operational thought it is necessary to establish the extent to which the observed performance changes satisfy each of the criteria described.

2.4 THE INFLUENCE OF SOCIAL LEARNING THEORY

The second major influence on the study of the relation between peer interaction and cognitive progress has been social learning theory which has proposed a mechanistic view of the acquisition of social behaviours. It has focussed attention on certain observable behaviours, such as aggression, and has been concerned with identifying the external stimuli which appear to influence their production. The fundamental axioms of social learning theory are the study of overt behaviours, rather than hypothesised internal agencies, which are assumed to be reducible to discrete units and which are under external stimulus control. Theorists adopting this approach have proposed imitation as the primary mechanism to account for behaviour change (e.g. Bandura and Walters, 1963), with operant conditioning being viewed as either a necessary or supplementary mechanism facilitating, inhibiting and shaping such behaviours (e.g. Aronfreed, 1969 ;

Gewirtz and Stingle, 1968). These studies have typically not attempted to induce a permanent social disposition but to demonstrate the power of their mechanisms to evoke certain behaviours. Their attention has been focussed primarily upon parent-child relationships as an influence upon development. However, the investigations of the relation between social interaction and cognitive change which have arisen within this framework have differed somewhat from this form. Their intent has been to induce a permanent developmental change resulting in the necessity to pre-test subjects to assess their initial levels of understanding prior to any social interventions. Furthermore, the models that have been adopted have been both adults and peers.

Generally two major categories of investigation have arisen to analyse the facilitative effect of peer interaction on cognitive development. One has involved the subject passively observing the performance of a more advanced person, which I shall term modelling studies and which have arisen within the framework of social learning theory. The other has examined active exchanges between peers which have arisen more within the framework of Piagetian training studies. In most cases the experimental design has involved individual pre-testing, some form of social intervention and then individual post-testing. Comparisons have been made with controls not given the social intervention, or between groups experiencing different forms of social intervention. In nearly all cases Piaget's conservation tasks have been employed. Initially, I propose to examine the evidence for cognitive reorganization as a result of these different social situations. I shall then consider the ability of different explanatory mechanisms, which have been suggested as mediators between peer interaction and cognitive change, to account for the existing evidence.

2.5 MODELLING STUDIES

Botvin and Murray (1975) have asserted that the key aspects of interaction needed for cognitive growth are simply the observation and imitation of an operational individual by a pre-operational child. They compared the effects of training non-conservers who either actively interacted with conservers or were in a modelling condition. The interaction groups were comprised of 3 conservers and 2 non-conservers who were instructed that they had to reach a consensus on six conservation problems. Subjects in the modelling condition were all non-conservers who simply observed the experimenter question each member of the interaction group before and after each explanation. At post-test significant gains were found on all conservation concepts for non-conservers in both conditions as compared with a control group who received no training. No differences were found between the two conditions. The authors proposed that any effects may be attributed most parsimoniously to a modelling mechanism that owes its effectiveness to the subjects' entertaining the conservers response resulting in a cognitive dissonance which fosters cognitive growth. It is interesting to note that this study differed from most other modelling studies in that several models were observed who expressed and defended different viewpoints. The presentation of conflicting judgements and explanations has been emphasised by other researchers and may have played a crucial role for both participants and spectators in this investigation.

Several other authors have supported the proposal that observation of a model can improve individual performance on problems of conservation (Denny and Acito, 1974 ; Kuhn, 1972 ; J. P. Murray, 1974 ; Rosenthal and Zimmerman, 1972 ; Sullivan, 1967, 1969 ; Waghorn and Sullivan, 1970 ; Zimmerman, 1974). However, it is unclear whether these passive exchanges produce a deep rooted change in cognitive structure or simply reflect superficial changes

in the level of performance. Silverman and Geiringer (1973) proposed that the exigencies of such experiments could induce the subjects to modify their responses simply because they interpret the instructions as an invitation to copy the behaviours displayed by the model. The subject's response is altered at the post-test because he thought he had to conform to the observed behaviours and not because his beliefs or conception of the phenomena had changed.

Some insight into the question of whether actual cognitive gain occurs after a modelling experience may be achieved by considering the extent to which the resultant conservation performances fulfil the criteria discussed earlier. Evidence for the production of novel conservation explanations, not heard during training, has only been found in cases where the subject was exposed exclusively (J. P. Murray, 1974) or partially (Botvin and Murray, 1975) to nonconserving judgements and not when only exposed to conserving judgements. The reason for this is unclear, however, simple imitation appears to be an inadequate mechanism to account for such findings. Evidence for generalization has been found by Botvin and Murray (1975), Murray (1974), Rosenthal and Zimmerman (1972), Sullivan (1969) and Zimmerman (1974). All generalization has been to structurally similar conservation problems which presents the possibility of transfer of behaviour to other similar situations without necessarily needing to invoke the idea of generalized understanding. The only evidence that performance changes are lasting comes from Kuhn (1972) who found that observed progress was still maintained one week later. No evidence exists as to whether conservation judgements trained by a modelling procedure can be extinguished. Overall, therefore, the evidence to support an increase in understanding as a result of a modelling experience is very limited.

Several authors who have accepted that a modelling

situation may produce cognitive change have argued against a simple imitation explanation. These proposals are in line with later theoretical formulations of social learning theory which have deviated from a strict behaviourist approach, proposing various internal processes as mediators between external stimuli and overt responses (e.g. Aronfreed, 1972 ; Bandura, 1974). Similarly some authors attempting to explain cognitive change as a result of a modelling paradigm have also invoked various cognitive processes. Botvin and Murray, themselves, appear to have moved away from their earlier emphasis on a modelling mechanism to an emphasis on a proposed dissonance mechanism (Murray, Ames and Botvin, 1977). To test this hypothesis they used a counter attitudinal role playing paradigm, in which children had to pretend to give conservation judgements and explanations opposed to those which they believed, while in the presence of another child. On the basis of cognitive dissonance theory it would be predicted that subjects would move in the direction of their public statements. They found very large, but unidirectional, changes to conservation judgements by nonconservers and partially conserving subjects who pretended to be conservers. No effects were found for conserving subjects who pretended to be nonconservers. In a replication experiment it was further found that these "trained" conservers were as resistant as "natural" conservers when asked to pretend to nonconserve. They concluded that dissonance was the pre-requisite for change but conceded that the unidirectionality of the observed changes ruled out an explanation based on cognitive dissonance alone.

An alternative explanation has been offered by Kuhn (1972). She assessed children's classification ability according to Inhelder and Piaget's (1964) six stages of classificatory development. They were then allocated to one of four modelling training conditions ; -1, 0, +1 and +2 according to whether the observed model performed at one stage below their own (-1) at their own level (0), or one or two

stages above their own (+1/+2). In all cases the model was an adult who gave appropriate verbal reasons to support his performance. She found that the +1 and +2 conditions were by far the most effective for inducing progress which, importantly, was nearly always to the +1 stage even for subjects who observed a +2 model. No evidence of change or regression was found for subjects who observed a 0 or -1 model. These findings clearly create problems for a simple modelling hypothesis which would predict that all models should be equally effective in producing behavioural change which should be in accordance with the behaviour observed. J. P. Murray (1974) has provided support for the finding that modelling induces change according to an invariant sequence of developmental stages. He also found support for Kuhn's finding of non-regression after observing an inferior model although contradictory results have been reported by Rosenthal and Zimmerman (1972). Kuhn argued for a structural model of behaviour change maintaining that developmental change proceeds in terms of an invariant sequence of successively more differentiated, elaborated and integrated structures. She proposed an optimal mismatch hypothesis suggesting that the best model to present to induce structural change is one that reflects the stage just above the child's own stage. This is the stage to which he is naturally progressing and the one for which he would be most likely to perceive the discrepancy with his own structure.

Generally, it is difficult to assess how successful a modelling experience is at creating cognitive change. However, the findings of authors like Kuhn strongly suggest that some models are more effective than others, and that the effectiveness of a particular model is a function of the child's own cognitive processes. Thus it appears that whatever changes do occur cannot be explained only in terms of an imitation mechanism. The subject's role may appear to be a passive one, but as Inhelder, Sinclair and Bovet (1974), observed, a child may be mentally active while not actually conversing or physically manipulating materials. One may therefore

view change as a result of a modelling procedure in terms of a kind of "tacit interaction" between the subject and the model.

2.6 INTERACTION STUDIES

Other researchers, working within the framework of Piagetian training studies, have considered the value of active interactions between peers of differing abilities. A series of training studies by Smedslund (e.g. 1961 I-VI, 1962, 1964, and 1966a) were influential as a stimulus to the development of this research. He investigated the effects of discrepant feedback for the child in his interactions with materials during conservation problems. He found little effect for these procedures and concluded that the limited impact achieved reflected the lack of social conflict involved. He suggested (Smedslund, 1966 II) that cognitive decentration would be facilitated, above all, by a confrontation of differing points of view between children, thus effectively restating Piaget's early view.

Later research found evidence of cognitive progress for non-conservers who engaged in exchanges with conservers in order to arrive at a consensus of opinion for judgements of conservation. Doise, Mugny and Perret-Clermont (1975), F. B. Murray (1972), Miller and Brownell (1975), Silverman and Geiringer (1973), and Silverman and Stone (1972) have all found evidence that nonconservers yield to conservers' arguments more than vice-versa during these interactions and later will produce conserving responses when individually tested. These changes appear to be relatively secure and lasting. F. B. Murray (1972) found that "trained" conservers generalized their responses to new and parallel problems. Silverman and Stone (1972) and Silverman and Geiringer (1973) found trained conserving responses still present one month later and found evidence of generalization to other non-trained conservation items. However, they report only one example of a novel explanation occurring at post-test. Perret Clermont (in Doise, Mugny and Perret-Clermont, 1975), on the other hand, has reported over 60% of "trained" conservers introduced novel arguments at post-test and that newly acquired judgements of conservations were

still present one month later. She later reported evidence of generalization to other conservation problems (Perret-Clermont, 1980).

F. B. Murray (1972) and Perret-Clermont (in Doise, Mugny and Perret-Clermont, 1975) used a paradigm in which two conservers and one nonconserver had to reach agreement on problems of conservation. Murray interpreted his findings as supporting Smedslund's (1966) argument that the growth of intelligence is more dependent upon the interaction between the child and those about the child, than between the child and the physical environment. Perret-Clermont reported evidence to support Smedslund's "conflict of communication" hypothesis arising from a confrontation between different cognitive levels, which makes a subject aware of contradictions in his mode of reasoning. However, she points out that progress may also be due to the fact that other children (not necessarily of a higher cognitive level) may make the subject aware of other points of view, or that the conserving children were in a majority which may permit them to impose their opinion on the single nonconserver. Silverman and Geiringer (1973) and Silverman and Stone (1972) supported the former proposal. Using a dyadic interaction situation between a conserver and a nonconserver, in which majority pressure could not be operating, they found that the predominant change was still for the nonconservers to adopt the conservers viewpoint. Although changes did take place in the opposite direction during interactions, these changes, unlike those from nonconservation to conservation, were unstable and not reflected at post-test. They proposed that the progress made by the nonconservers was in harmony with the Piagetian equilibration model and emphasised the importance of social conflict and contradictions in the formulation of new perspectives. Silverman and Litman (1978) have also found evidence that conservers' viewpoints prevail in discussions of conservation with nonconserving peers. Furthermore they reported that subject with a relatively advanced subjective moral orientation predominated in discussions of moral problems with peers whose morality was more objective. Both of these findings were again interpreted as consistent with the Piagetian equilibration model.

Miller and Brownell (1975) investigated whether the progress observed as a result of these asymmetrical encounters could be explained in terms of a dominance which the conserver exerts over the nonconserver. They found that conservers did indeed dominate interactions with their less advanced peers, however this dominance was strictly limited to conservation tasks and was not present when these same pairs were engaged on other nonconservation tasks. During conservation tasks conservers were more likely to assert their answers at least once, to produce counter arguments and to manipulate the stimulus material. In contrast nonconservers appeared to be limited to a restatement of their original perceptual response. These findings are in harmony with those of Perret-Clermont (Doise, Mugny and Perret-Clermont, 1975) who found that the most effective interactive situation was one where the conserver argued in a consistent and coherent manner and that if nonconserving or intermediate behaviour was shown by the conserver, even momentarily, then the training situation became less effective. These authors emphasised the importance of verbal arguments and explanations expressed with clarity and conviction during interactions. Miller and Brownell proposed that nonconservers yield to conservers because they exert a stronger social influence during conservation arguments due to a belief in conservation being more firmly held than a belief in nonconservation. This was supported by Miller, Brownell and Zukier (1977) who found greater confidence in operational than non-operational answers.

2.7 CONFLICT AND COGNITIVE REORGANIZATIONS

In the interaction studies described so far, the nonconserving child has been confronted with a partner who both disagrees with him and offers an operational solution. Thus, two of the possible explanations proposed by Perret-Clermont are still confounded. Namely, it is unclear how far the fact of disagreement is sufficient to promote cognitive restructuring quite apart from the provision of an operational solution. In fact Miller and Brownell noted that the mere presentation of a contradiction was often sufficient to produce a change in response. Heber (1978), looking

at the role of speech in developing cognition, attempted to clarify this issue by contrasting the effects of "guiding" dialogue with "reciprocal" symmetrical dialogue. Using a seriation task she compared the performance of children at post-test who had experienced a discussion with an experienced adult who guided and elicited appropriate descriptions for relations of series, with those who had been trained with peers of equal cognitive status who discussed their solutions together. She found that while there was plenty of discussion and disagreement between the peers, only after the "guidance" experience was there significant individual improvement in relation to a control group. Heber argued that contention between peers of equal ability was insufficient to induce cognitive progress and that there had to be a close liaison of appropriate and directed speech and action for serial understanding to develop within a social situation. Russell (1979) also set out to compare the facilitatory effect of interaction between equal peers (both nonconservers) with that between unequal peers (a conserver and a nonconserver). He found that experience with a conserver was significantly more facilitative of nonconservers' performance at post-test than an interaction with another nonconserver. He supported the Miller and Brownell proposal that conservers tend to have their viewpoint adopted by the nonconserver because they make more opposing judgements and provide a greater amount of principled justification than their partners. He further replicated the finding of Miller and Brownell that this dominance was only for conservation tasks and not for other tasks. He concluded that cognitive conflict in the absence of an operational viewpoint does not lead to cognitive change. He later reiterated this position using a spatial task and a class inclusion problem (Russell 1981 a, 1981 b). He argued that correct solutions arising during dyadic interactions were generally based on the incorrect child's compliance with the correct partner's judgement rather than upon co-operative co-ordination of perspectives.

However, the conclusions of Heber and Russell are in conflict with the findings of a team of researchers working in Geneva. Doise and his co-workers (Doise, Mugny and Perret-

Clermont, 1975 ; Doise, 1978; Doise and Mugn y, 1976, 1979 ; Mugny and Doise, 1978) have embarked on a series of experiments examining Piagetian concepts, including conservation attainment, on the basis of the social nature of knowledge. They believe that social interaction is characterised by its' constructive nature ; that social co-ordination precedes the individual's co-ordination of the same actions, and that "socio-cognitive conflict is an important factor in all restructurations, whether collective or individual" (Mugn y and Do ise, 1978, p.183). They have argued that during an interaction a child need only be confronted by another who expresses a different viewpoint and not necessarily by one who advances the correct viewpoint, in order for each individual to acquire greater understanding of a notion (Do ise, Mugny and Perret-Clermont, 1976 ; Mugny and Do ise, 1978).

Do ise et al (1976, also reported in Perret-Clermont, 1980) argued that if cognitive change were a consequence of a socio-cognitive restructuring induced by a conflict of cognitive centrations, then subjects would improve their understanding of conservation of length both when an experimenter proposed an incorrect but contradictory position based on "symmetrical centration", as well as when an experimenter proposed a contradictory but correct solution. Indeed progress was found for subjects in both situations as compared with a control group. Mugn y and Doise (1978) have presented further evidence which suggests that a correct viewpoint is not an essential element in a social encounter for cognitive restructuring to ensue. Using a spatial co-ordination problem they found that a non-superior but conflicting partner aided more advanced peers to progress. Further support for this proposition has been found for children working on multiple classification tasks and related problems of right-left relations (Valiant, Glachan and Emler, 1982). Similar findings have also been obtained by Perret-Clermont (1980) investigating the development of spatial relations in children's drawings. She proposed

> "that the cause of the cognitive development observed is to be found in the conflict of

> centrations which the subject experiences during the interaction. The interaction obliges the subject to co-ordinate their actions with those of others, and this brings about a decentration in the encounter with other points of view which can only be assimilated if cognitive restructuring takes place" (p. 148).

These findings support the hypothesis that not only conflict with a more advanced viewpoint, but also conflict with a parallel or even inferior position may be productive of cognitive change.

Further investigations have been carried out in an attempt to clarify some of the features of an interaction which may facilitate performance change. Doise and Mugny (1978) examined the possibility that the process of cognitive restructuring may be dependent upon the relative discrepancy in ability between the children paired together. Using a spatial transformation task they classified subjects as non-conservers, partial conservers and total conservers according to their pre-test performance. They generally found that pairs of children who manifested different levels of ability progressed, whereas two children using the same strategy did not profit from their interaction. They suggested that these latter pairs approached the task from the same viewpoint and, as a result, their interaction did not result in a conflict of centrations. They later demonstrated that such pairs would acquire spatial transformation skills if they physically approached the problem from opposed viewpoints, thus inducing conflict (Doise and Mugny, 1979). However, a closer examination of the findings of the earlier study reveals that things were not so clear cut. While no benefits were observed after interactions between children of like centration who were non-conservers, clear progress was found at post-test for partially conserving children who had interacted with each other. It was suggested that this may be due to oscillations in partial conservers' strategies, which may result in conflict. Furthermore, not all pairs whose members manifested different levels of centration progressed. Conserving and non-conserving subjects working together frequently produced correct responses during training but no evidence of individual gain was observed. This is clearly

contrary to the findings of Silverman and Geiringer (1973) and Silverman and Stone (1972). Like these authors Doise and Mugny found that encounters of this nature were dominated by the conserving partner, but proposed that they were unprofitable due to the conserver excluding the nonconserver from the interaction and argued that both partners must co-ordinate their different approaches. Doise found further support for the proposal that dominance can be disruptive in a study using a motor co-ordination task (Doise, 1978), in which it was found that the introduction of status differences reduced the progress made by subjects

In the same study Doise found that if subjects were not permitted to speak to one another performance was disrupted resulting in little individual progress. An observation which reinforced his emphasis on the vital role of verbal communication.

Perret-Clermont (1980) commenting on the interpretation of such findings proposed that :

> "If the developmental gap between two partners is too great, there is a risk that the subject will not be aware of any conflict, or will not understand the nature of the conflict. If the partners are at the same developmental level, or if the other is less advanced, the subject can only benefit from the interaction if there is a conflict i. e. if the difference in centrations and the nature of the collective task call for re-organization of the co-ordination between the partners" (p.172).

Considering the problem of why two nonconservers paired together do not progress as a result of their interaction she proposed that before a subject is aware of conflict the

> "subjects must be able to see the difference of position between their partners and themselves, and that they are capable of going on to effect a reconciliation .... that only those NC (non-conserving) subjects who have nevertheless already reached a certain level of conceptual elaboration will have the cognitive basis needed to be able to benefit from the confrontation, and therefore to proceed to an intellectual restructuring" (p.119).

Using a conservation of number task she found support for this hypothesis. She claimed that subjects below a certain level of development are not unable to participate at all in social interaction but that there is a minimum developmental level that they must have reached on a specific ability for a specific experimental procedure to have any effect. She proposed that other interactive situations in which these subjects were exposed to behaviour at a level immediately superior to theirs, could be devised which would be beneficial.

Perret-Clermont (1980) has proposed a spiral model of development in which changes resulting from social interaction will subsequently allow an individual to participate in other interactions which will in their turn be the basis of new development. She has adopted an interactionist and constructivist view considering the genesis of cognitive structures as resulting from an active re-structuring by the child of his own representation of reality. Accepting Piaget's theory of equilibration she suggests that cognitive conflict acts as a kind of catalyst which does not create the forms that operations take but brings about disequilibria which make cognitive elaboration necessary. Conflicts arising within a social encounter is given a special role as one factor, among others, that may lead to increased understanding.

2.8 OVERVIEW

It is clear that the imitation and cognitive dissonance hypothesis (Botvin and Murray, 1975), the optimal mismatch hypothesis (Kuhn, 1972) and the social influence hypothesis (Miller and Brownell, 1975) are unable to account for many of the findings of Doise and his co-workers, and are even unable to fully account for some of their own findings. Specifically they are unable to explain non-regression after observing an inferior model and are clearly unable to account for progress made by more advanced subjects who interact with a less advanced peer. It is unclear, also, how they would account for the appearance of novel

behaviours, whether these are produced by the more or less advanced member of a dyad. Perret-Clermont (1980), has, however, attempted to account for the findings from the modelling situation and the active asymmetrical interaction situation in terms of conflict theory. She interpreted the changes occurring after a modelling experience as due to the subject experiencing a conflict between the observed behaviours and those which he or she would have deployed. This conflict, so far as the subject is at an opportune stage of development, triggers off the mechanisms of cognitive re-organization. Thus observing a model is viewed as a particular instance of the effects of cognitive conflict in social interaction. In relation to the social influence hypothesis she attempts to explain the benefits that accrue not in terms of influence, persuasion or dominance, but by the fact that a conserver is highly likely to present to a nonconserver a clearly elucidated viewpoint different from his own.

In a general sense many of the findings of researchers using different social contexts can be explained in terms of a conflict theory. Yet it is not clear that all of the findings can be adequately accounted for in this way. In particular it is not clear how social conflict can account for novel behaviours any more than other proposed mechanisms of change. Brainerd (1978) has indicated that Botvin and Murray's (1975) demonstration that passive observation of a model can be productive of cognitive change, is contrary to Piaget's equilibration model which is based on active restructuring by the child. Now, although Perret-Clermont, (1980) argued that modelling can produce social conflict, Brainerd's point about the passivity of this modelling condition also contradicts her neo-Piagetian equilibration model, in which it is proposed that improvement depends upon direct and active interaction, invoking inter-individual discussion of the problem (also Doise, 1978). It is further unclear how Doise and his co-workers can invoke mechanisms of conflict to explain the progress resulting from a nonconserver observing a conserver when they failed to find any evidence of benefits from active encounters between such pairs, and when at the same

time Perret-Clermont has argued for an optimal gap between the cognitive levels of the interacting subjects.

One important element which may account for some of the discrepant findings of different authors is the nature of the tasks which they have adopted. As Heber (1978) pointed out, performance on a spatial transformation task is particularly likely to be aided by the synthesis of different spatial viewpoints when considered by a pair of children. This may be less likely in tasks where logical relations over-ride spatial perspective notions as in most of the conservation tasks. The difference in the nature of these two kinds of task may be responsible for the discrepant findings observed in relation to the benefits that accrue for a naive child interacting with a partner who is fully conversant with the task. Clearly verbal labelling and rule giving are possible for many conservation problems and conservers dominating interactions on these problems have been observed to verbally explain and defend their position. However, the spatial transformation task used by Doise and his associates does not lend itself so easily to rule giving and explanation and a dominant partner may be unable to defend and explain his actions. Thus, the nature of these two, quite different sorts of tasks, may structure the social situations in ways that make them qualitatively quite different. It also appears that the roles individuals adopt appear to vary between the same individuals with different tasks (Miller and Brownell, 1975 ; Russell, 1979).

Another important factor which may influence the benefits that arise from interactions is the levels of understanding each child brings to the encounter, although the exact nature of this influence appears somewhat confused. Some authors have argued that optimal benefits will be achieved with interactions between two subjects, one of whom is at the developmental level just above the other (e.g. Kuhn, 1972 ; Perret-Clermont, 1980). It has also been proposed by Perret-Clermont (1980) that subjects must have at least a certain level of cognitive elaboration in order to recognize a conflicting viewpoint and attempt a reconciliation of discrepant

positions. Other authors have, however, recorded benefits from interactions between subjects with widely divergent levels of understanding (e.g. Silverman and Geiringer, 1973 ; Silverman and Stone, 1972), and have found evidence of progress by subjects at the lowest developmental levels.

Researchers, largely due to their differing theoretical orientations have devised different encounter situations and invoked different mechanisms to explain observed changes in performance. Research deriving from social learning theory and that from Piagetian theory have relied on different paradigms and researchers have studied those situations which their particular paradigm is best suited to handle. A primary feature which has been emphasised in these social situations is the mode by which opinions are transmitted, some authors have asserted that passive observation of another's viewpoint is a sufficient prerequisite for behaviour change. Others have emphasised the verbal transmission of a correct viewpoint while finally some have argued that the presentation of any discrepant viewpoint may be sufficient to incite developmental change. Conflict theory has come closest to accounting for the majority of findings and has proposed that the recognition of opposed centrations may result in the co-ordination of those centrations, although little attention has been given to how this co-ordination occurs.

Clearly there is a complex interaction of factors operating during any social encounter. The interactants bring a wide variety of skills and abilities into the test situation which may itself vary in many important ways and the apparent task dependence of any detailed analysis of peer interaction is a problem yet to be fully considered. Furthermore, the dependence of much of this research on Piaget's conservation problems has produced much confusion in the interpretation of the extent of cognitive progress resulting from social interactions between peers. The research presented in the following chapters will consider some of the problems and issues developed in this discussion. Particular attention will be given in the next chapter to a preliminary examination of the influence of task structure upon the learning situation and upon the associated

social exchanges between peers. It will also consider the issue of whether children of similar ability can benefit from interactions with each other, and therefore whether it is necessary for a more advanced partner to be present who can guide his less advanced peer.

CHAPTER 3

A PRELIMINARY INVESTIGATION OF TASK STRUCTURE AS A DETERMINING FACTOR OF INTERACTIVE BEHAVIOUR BETWEEN PEERS

3.1 THE PROBLEM TO BE CONSIDERED

A critical issue facing researchers engaged in the study of peer interaction is the need to define the situation within which these interactions are being observed. Clearly, social encounters do not take place within a vacuum and the nature of the exchanges will be dependent upon the context and setting within which they occur, as well as upon the personal attributes of those involved and the focus of their attention. Of particular importance to the investigation of peer interaction within a problem solving situation is the structure of the task under examination. Problems vary in the demands they make upon subjects and the encounter will be structured around those behaviours appropriate for the achievement of an adequate solution. The influence of the task on the efficacy of peer interaction as a facilitator of cognitive development is an important issue requiring consideration.

To date, researchers have largely adopted Piaget's conservation tasks as the medium within which to observe peer interaction. The problems presented demand the recognition or representation of the permanence or identity of objects through various changes in form or perspective. These tasks are generally non-manipulative ; the subject being asked to judge the perceptual equivalence of two arrays with respect to some invariant property (e.g. number, length, weight) and to justify their responses. Peers, who hold different viewpoints, when asked to reach a consensus do so largely via verbal argument, with conserving children justifying their position with explanations in terms of identity, reversibility or compensation. It has been argued by Silverman and Stone (1972) that an interactive experience with

a conserver may provide non-conservers with a verbal algorithm or model (Beilin, 1965), for solving conservation problems. This explanation is consistent with their finding that nonconservers, after interacting with conservers, justified their answers with the same explanations articulated by their conserving partners during the interaction sequence. Other evidence for the efficacy of a verbal model comes from several investigators (Beilin, 1965 ; Hamel and De Witt, 1971; Sjoberg, Hoijer and Olson, 1970 ; and Smith, 1968) who reported successful conservation training outcomes using verbal rule instruction as a training procedure. Only Mermelstein and Meyer (1968) have failed to obtain positive results with verbal instruction. Sullivan (1967) found that simply watching an adult explain conservation principles was sufficient to induce conserving performances in subjects. Sullivan interprets these results as supporting the view that language is the foundation of all rational activity, with conservation being a fundamental example of such activity. Beilin (1965), however, pointed out a limitation in the effectiveness of a verbal model : namely that there was no evidence of generalization to nontrained properties. He concluded that :

> "Some element beyond verbal model training is necessary for "full" conservation, which no other training procedure is able to provide either, but which is achieved in less formal settings". (p. 337.)

Some of these elements may be present in the encounters between peers of unequal ability which have produced evidence of generalization. However, the role of verbal discourse during such encounters has still been consistently emphasised as a particularly important element of the interaction. Miller and Brownell (1975) pointed out that, during an interaction between a conserver and a non-conserver, the conserver is more likely to assert his answer at least once and to produce counter arguments. They found that on nearly half of the trials conservers produced as many as three or more distinct arguments to defend their position. It is apparent that verbal transmission of rules and principles

is likely to occur during a social encounter considering a conservation problem and appear to be an important factor in determining the progress made by non-conservers.

However, in the field of spatial judgements the cognitive conflict view of dyadic interaction carries most force, because it is here that perspective clashes may be quite literal. Not surprisingly it is spatial tasks that Doise and his associates (Doise et al, 1975 ; Doise and Mugny, 1979 ; and Mugny and Doise, 1978) have employed to elaborate the conflict of centration model. The important difference between the logic of this and the conservation studies is that incorrect responses are not verbal judgements about physical properties but placements (or judgements about placements) of items. Such problems are not conducive to verbal rule giving or principled justifications of one's behaviour and as such little attention has been given to the verbal discourse occurring when considering these problems. Tasks of this kind are more manipulative and the nature and content of exchanges occurring appear to be quite different from those characterizing interactions relating to conservation problems.

Clearly, any analysis of interactions must be viewed within the limitations imposed upon those interactions by the task being undertaken. The kind of exchanges that take place will be partly dependent upon the task environment, and a formal analysis of the environment can help define the range of possibilities. Furthermore, it is obviously important to be able to define what the subjects are learning in any particular task. This has clearly not been the case in studies which have adopted conservation problems in that the criteria for assessing performance on these tasks are widely disputed. For any task different subjects may in fact learn different things under the same conditions. Preliminary insights can be gained by analysing the structure of the task itself in order to determine alternative ways of performing it.

This first study set out to examine some of these issues using a task known as the Tower of Hanoi. It was decided to

examine the limitations this task imposed upon a dyadic interaction and also to consider the different methods children adopted to solve this problem. The aim of the investigation was to provide a base upon which further investigations of dyadic interactions could be undertaken while subjects were engaged on the Tower of Hanoi problem.

3.2 THE TASK : THE TOWER OF HANOI

The Tower of Hanoi was invented by the French mathematician Ed ward Lucas and was first sold as a toy in 1883. It has proved to be a suitable task environment in which to study a variety of problem solving processes (Egan, 1974 ; Gagne and Smith, 1962 ; Hayes and Simon, 1974; Horman, 1965 ; and Simon, 1975). It is a well-structured problem having a well defined initial state, a well defined goal state, and a set of logical operations that, when applied in the appropriate sequence, can transform the initial state into the final state. The problematical aspect derives from the fact that the sequence of operations is not immediately apparent to the problem solver, but rather must be produced through some combination of trial and error, means ends analysis, systematic search, testing, planning and so forth.

The To wer of Hanoi puzzle involves three vertical pegs or poles fixed into a block of wood (in this case one pole was red, one green and one yellow, see Figure 3). At the outset a number of discs of very clearly different diameters are threaded on one of the poles. They are arranged pyramidally with the largest disc on the bottom. The problem is to transfer the tower of discs to either of the two vacant pegs in the fewest possible number of moves, moving only one disc at a time and never placing a larger disc on top of a smaller one.

It is not difficult to prove that there is a solution regardless of how many discs make up the tower, and that the minimum number of moves required to solve a problem is expressed by the formula

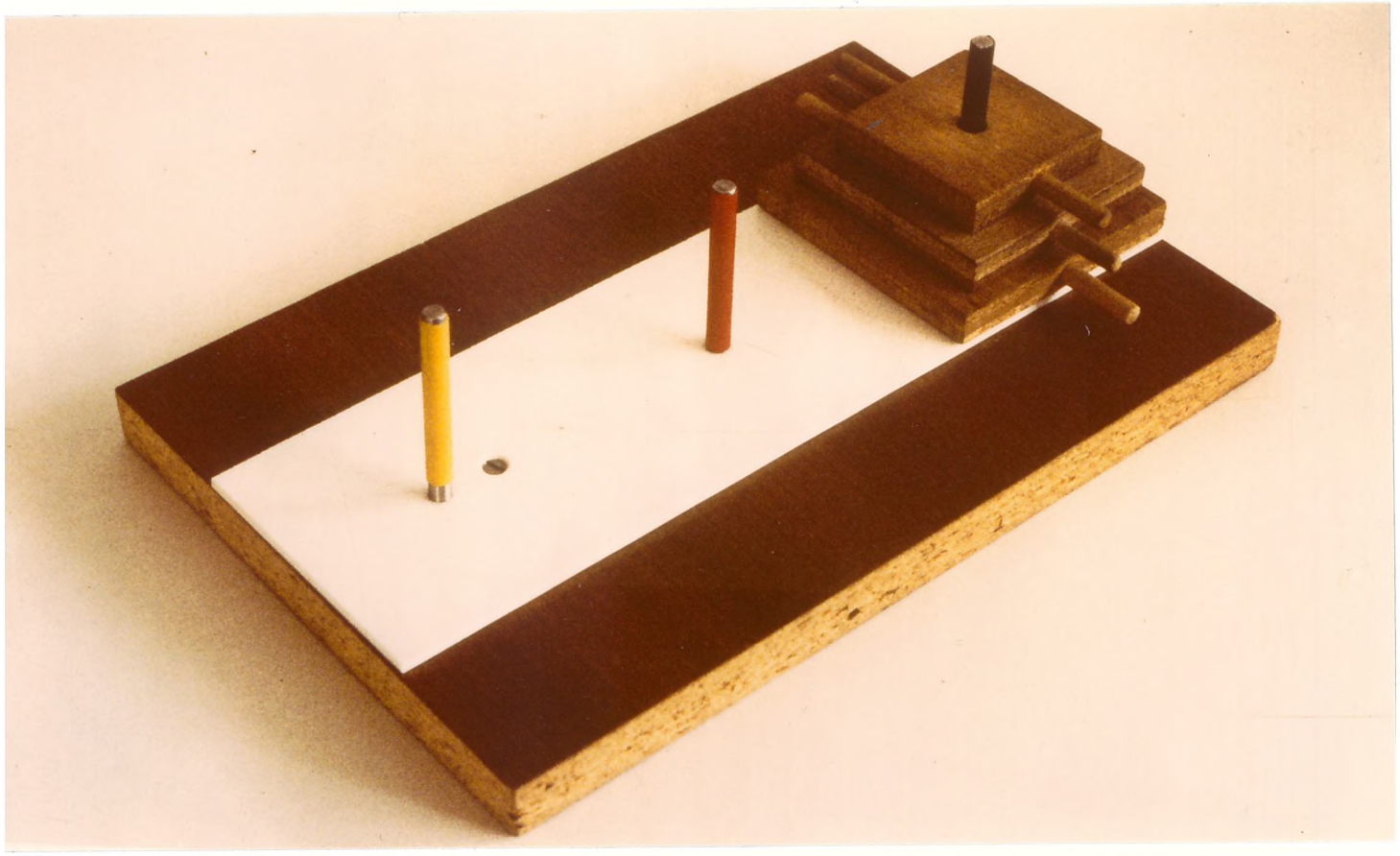

Figure 3.1 The Tower of Hanoi

$2^n - 1$ (n being the number of discs). Thus three discs can be transferred in 7 moves, four discs in 15 moves, five discs in 31 moves and so on. To solve the problem one must use all three poles. For example, if two discs are used the smallest disc has first to be moved to the intermediary pole and then to the goal pole, after the larger one has already been placed there. The first move is of critical importance ; with an odd number of discs the first move with the smallest disc should be to the pole upon which all the discs must eventually arrive ; with an even number of discs the first move should always be to the intermediary pole. On the optimal solution of the problem transfer of the smallest disc should take place on every other play moving back and forth in a clear sequence of moves. For the remaining plays the subject should make the only transfer possible that does not involve the smallest disc. In this solution the largest disc will move only once, the second largest twice, the third largest four times and so on, depending on the number of discs. The problem involves the combinations of a type of transitivity of the discs successive positions and a type of recurrence.

The Tower of Hanoi Problem has a natural decomposition into nested subproblems. For example, to solve the 4 disc Tower of Hanoi it is necessary at some point to move the largest disc from the starting pole to the goal pole. But before this can be done the three smaller discs must be assembled in their proper order on the other intermediary pole. This problem of moving the top three discs has been described as a 3 disc sub-problem of the 4 disc Tower of Hanoi (Luger, 1979). Thus overall the 4 disc task is comprised of two 3 disc sub-problems which are themselves comprised of four 2 disc sub-problems. Similarly the 3 disc task is comprised of only two 2 disc sub problems. Thus, if a child learns to solve the 2 disc problem, on then attempting the 3 disc problem he has to learn to string together two 2 disc subproblems in the required way separated by the move of the largest disc. Together this constitutes the 3 disc problem, two of which have to be strung together in the required way to solve the 4 disc problem, again they will be separated by the move of the largest disc.

Studies investigating young children's performance on this task have found that they perform quite poorly. Piaget (1977) used 2, 3 and 4 disc problems with children aged between $5\frac{1}{2}$ and 12 years and proposed three stages of understanding. Piaget reports that most 5 and 6 year old children

> " cannot move the three disc tower even after trial and error. They do succeed in moving the two disk tower, but only after all sorts of attempts to get around the instructions and without being conscious of the logical links" (p. 288).

From this performance Piaget concluded that none of these subjects make plans or understand how they are going to move the tower. Between $7\frac{1}{2}$ and 9 years of age children were found to show

> "immediate success with the 2 disk tower. With the 3 disk tower, there are still hesitations, errors, modifications, but the correct solutions become stable" (p. 291).

Piaget proposed that a better subordination of means to ends had developed due to progress in the ability to make predictions. This differentiates the performance from the first stage in which each particular action becomes an end in itself with the general aim forgotten. By 11 to 12 years children's performance was

> "Characterized by rapid and stable success in the three-disk tower and by an increasingly inferential anticipation in the case of the towers with more discs, together with an explicit use of earlier experience". (p. 297).

He suggests that subjects of this age elicit a sort of general model which can then be applied to a variety of situations. Some support for these findings has been provided by Byrnes and Spitz (1977 ; cited in Klahr, 1979). They found that on the 2 disc problem 6 and 7 year olds made errors on about one out of three trials, but that 11 year old children were nearly perfect. Almost

all the younger children failed the 3 disc problem and even the older children could not solve it more than half of the time.

The Tower of Hanoi is evidently a complex problem for young children, thus permitting plenty of scope for progress and understanding to develop. It has a clearly defined structure with the operations children carry out being easily accessible to close monitoring and examination. As such it appeared to be a task well suited for my purposes.

3.3 AIMS

This study set out to investigate two main issues. Firstly, to examine the nature of the task known as the Tower of Hanoi and to consider the limitations it may impose on an interactive situation, Secondly, to consider whether two children performing at the same inferior level can, under certain conditions, profit from their interaction when confronted with a more cognitive and less perceptually oriented task than that used by Doise and Mugny (1979).

3.4 METHOD

Subjects

44 children, drawn from a school in the Southampton area, took part in the investigation. The intake of the school was predominantly from an area of low socio-economic status. There were 17 girls and 27 boys in the sample with a mean age of 8.8 years, within the range 8 years 3 months to 9 years 2 months. These children constituted the yearly intake of the school, 18 of whom had been placed in a remedial class while the remaining 26 made up an average mixed ability class.

Design

The experiment was divided into three sessions : a pre-test, an intervention session and a post-test. All subjects were individually

pretested on the Tower of Hanoi. They were then randomly allocated to one of three training conditions, two of which were paired interactive situations while the third was an individual control condition. In both interaction conditions the children making up the pairs were matched together as closely as possible on the basis of their pretest performance. All subjects were post-tested individually. During each trial the experimenter recorded the sequence of moves made by the subjects on specially designed score sheets. The sessions were separated from each other by periods of approximately ten days.

3.5 PROCEDURE

Introductory Meeting

Previous experience had suggested the importance of establishing a rapport with the children in order to reduce their inhibitions and to create more relaxed experimental situations. One cannot necessarily expect children to interact freely and constructively in a novel environment. They may well entertain fears and suspicions regarding both the experimenter and the task they are being asked to perform. Unless attempts are made to overcome these barriers the extent and nature of the interactions observed may be misleading and may misrepresent the possible benefits that could result from an interactive experience. Researchers have generally paid little attention in the literature to the issue of developing an atmosphere conducive to the children feeling uninhibited in their actions and interactions. There is little or no reference to any steps they may have undertaken to establish such an environment which may have important consequences for the observed behaviours of subjects.

Rapport is a complex social process through which the field worker may enter into relationships with those he observes, relationships he discovers, selects or creates in order to obtain the information he seeks. To achieve this end, within this study I attempted to integrate myself into the children's school life as much as possible. I was present in the classrooms whenever

permitted during a two week period prior to the commencement of the study. I helped at breaks, ate dinner with the children and helped supervise sports days and school trips. Furthermore, I informally met each child invididually for a chat before the test sessions began. These meetings were unstructured and developed in many diverse ways as is the case with everyday conversations. Discussions ranged from the child's life both in and out of school, his interests, friends and peer groups to the experimenter's life, his interests, job and what he was doing at the school. The intention of these sessions was to put the child at his ease and thus help to make the testing situation as pleasant and stress free as possible.

Pretest

All the subjects were pretested individually in an experimental room which was a small library near their classrooms. All the children had used the room frequently and were familiar with it. A few friendly verbal exchanges took place before the experimenter introduced the task into the situation. The subject was seated opposite the experimenter with a table between them. The Tower of Hanoi was placed on the table and the subject's attention drawn to it. They were initially told a story about the legendary 'Tower of Brahma' from which the Tower of Hanoi supposedly developed. This story enabled the experimenter to introduce the problem in a relatively informal manner. This was followed by a more detailed physical description of the Tower of Hanoi.

The subjects were then asked to place two discs of differing diameter on one of the poles with the larger one on the bottom. They were instructed to try and move the discs to one of the other two poles in as few moves as possible but it was emphasised that they were only allowed to move one disc at a time and were never allowed to put a larger disc on top of a smaller one.

The subjects carried out two trials from the red pole to the yellow pole, (the two end poles), and then one reversal trial from the yellow to the red pole. This was in order to discover if the

child wrongly conserves his initial approach without accommodating it to the new situation, or whether he correctly conserves only the method, adapting it immediately to the modified reversal conditions. Nearly all subjects found these initial trials with 2 discs quite simple and most of them correctly solved all three problems in the optimum three moves. The others all solved the problem correctly on two out of the three occasions. These early trials were useful for overcoming any misunderstandings of the rules and also to enable the subjects to get used to moving the discs. A third disc was then added to the tower. It was emphasised that the rules were still the same and they were again reiterated. Subjects once more had to perform two trials from the red pole to the yellow pole and one from the yellow pole back to the red pole. At the end of this group of trials each subject was asked to describe verbally how he would solve a 3 disc problem. The completion of these three trials signalled the end of the pre-test session.

Training

Subjects were randomly allocated to one of three training conditions. In two of these conditions subjects worked in pairs, while in the other they worked alone. Within the paired conditions the dyads were matched for ability according to the total number of moves they had taken to solve the 3 disc pretest problems. In all conditions the task was again described to the subjects as in the pre-test sessions and the rules again repeated. Subjects were required to complete four trials all starting from the centre pole and alternating between the two end poles. Finally, each subject was again asked to verbally describe how he would carry out a 3 disc problem. Subjects allocated to the individual condition were given the same instructions to those given at pre-test.

In one of the paired conditions subjects worked co-operatively towards the same goal, while in the other they competed against each other, each having different goals. In both situations the subjects sat opposite each other with the Tower of Hanoi between them.

In the co-operative condition they were instructed to work together in order to move the discs to the goal pole and also to take turns at moving the discs. They were informed that they must agree upon each move before it was made and that no disc should be moved by either of them independently without prior consultation with their partner. The privilege of making the first move was also alternated between trials.

In the competitive situation subjects were told that they were going to play the game against each other. One subject was instructed that he had to attempt to move all the discs to the yellow end pole while his partner was required to move them to the red end pole. Again they were told that they had to take turns at moving the discs with the further limitation that they were not permitted to move the disc moved on the preceding turn by their partner. This produced several instances in which subjects were constrained to move a disc against their own interests since this was the only legal move available to them. Again the privilege of making the first move was alternated. This was a critical factor in this condition since the subject who made the first move controlled the smallest disc and could not lose the game unless he purposefully made the final move to complete his opponent's tower. This resulted in both subjects generally each winning two trials.

Post-test

This third phase of the investigation was again carried out with subjects individually. The format of this session was identical to the pretest session.

3.6 RESULTS

Intra group t tests between the total number of moves subjects required at pre and post-test for the 3 disc problems indicated significant improvements by subjects in all three conditions (Individuals : $t = 2.77$; $p < 0.05$; co-operative : $t = 3.13$; $p < 0.01$;

competitive : $t = 3.30$; $p < 0.01$). A comparison of post-test performance across all conditions, using total scores for the 3 disc problems, revealed significant performance differences ($F = 4.7$; $p < 0.05$). Separate comparisons between the conditions found no group differences at post-test between the individual and co-operative conditions ($t = 1.28$), nor between the co-operative and the competitive conditions ($t = 0.42$). However the performance at post-test by subjects in the competitive condition was found to be significantly better than that by subjects trained individually ($t = 2.14$; $p < 0.05$).

Subjects were segregated, according to pre-test performance, into those who had on average taken fourteen moves or less to solve the 3 disc problems and those who on average had taken more than fourteen moves (rationale to be provided shortly). A 1 way ANOVA comparing post-test performance in all three conditions for the less advanced group was insignificant ($F = 0.37$), but significant differences were found for the more advanced group ($F = 5.48$; $p < 0.05$). Comparisons between the conditions for this advanced group revealed no differences between subjects in the individual and co-operative conditions ($t = 1.14$) nor between the co-operative and competitive conditions ($t = 1.78$), but subjects in the competitive condition were again found to be superior to those in the individual condition ($t = 3.50$; $p < 0.01$).

The verbal descriptions elicited from subjects were not informative of their approach to the task. Subjects who successfully completed the 3 disc problems in the optimal manner were generally also able to describe the seven move sequence. They rarely, however, produced rules or explanations defining their general method of performance. Several subjects who solved the problem in more than seven moves were also able to describe these longer sequences. Others got confused and were unable to complete an explanation without physically manipulating the discs, thus providing a visual display to follow. Generally subjects were only able to attempt a verbal description of the moves they would make to solve the problem but were unable to produce general principles

to define a solution.

3.7 THE NATURE OF THE TASK

Although no formal record was taken of the interactions, it was apparent that the Tower of Hanoi did structure the exchanges in a quite specific way. Due to the mathematical complexity of the rules governing the make-up of this task, subjects were unlikely to defend a particular approach to the problem with clear verbal explanations nor to provide systematic rules for the problem's solution. Even subjects who had successfully completed the task were unable to describe or provide general rules defining the structure of their strategy. The Tower of Hanoi differs crucially from conservation problems in this respect, with the role of verbal discourse during interactions being consequently diminished. It shares this non-verbal orientation with the spatial transformation tasks adopted by Doise and his colleagues, although clearly the cognitive abilities in question are quite different. It was evident that the amount of verbal discourse that occurred during interactions was limited and generally not instructive. The Tower of Hanoi engaged the children particularly in the physical manipulation of concrete materials in their attempts to achieve a solution. In social situations it appeared possible for children to test out differences of opinion through action and to engage in active hypothesis testing.

An examination of the sequences of moves used by subjects to solve this problem revealed that they adopted a number of distinct strategies to solve the 3 disc problem. The optimal strategy, as was described earlier, takes seven moves. It is made up of a two disc sub problem to the intermediary pole (3 moves), the move of the largest disc to the goal pole followed by a further 2 disc sub-problem moving the two smaller discs on top of the largest one. Another frequently occurring strategy took nine moves. This was comprised of an incorrect first move resulting in the first 2 discs subproblem taking five moves instead of three. This was followed by the move of the largest disc and then a correct 2 disc subproblem.

The next frequently occurring pattern took eleven moves. In this instance the top two discs completed a full incorrect subroutine arriving at the goal pole instead of the intermediary pole. This was followed by the move of the largest disc to the intermediary pole and a further 2 disc subroutine moving the two smaller discs back to the starting pole. This permitted the largest disc to be moved, for the second time, to the goal pole. Finally the remaining two discs would be manoeuvred into place on top of the largest disc. This solution was thus comprised of three 2 disc subproblems each taking three moves, and two moves of the largest disc. Frequently during this sequence subjects would carry out a faulty 2 disc subproblem taking five instead of three moves. This generally occurred during the second 2 disc subproblem resulting in the subjects nearly completing the problem to the intermediary pole as opposed to the goal pole. This produced a thirteen move sequence. Where children took eight, ten, twelve or fourteen moves, they had almost always followed one of the sequences outlined above but at some stage made a false move and corrected it, thus adding one more move to the total. Solutions taking more than fourteen moves typically showed no clear strategy and contained sequences of apparently random moves. This observation gave rise to the categorization mentioned earlier for advanced and less advanced subjects. The distinction being dependent upon whether or not subjects had generally shown evidence of strategic approaches to the problem. Those children who took twenty moves or more on a single trial generally gave up and failed to complete the problem.

The occurrence of these strategies and non-strategies are shown in Figures 3.2 and 3.3. They show, in a graph form, the frequency with which solutions requiring different numbers of moves occurred at pre and post-test. While the X axis, which represents discrete numbers of moves, is not technically a continuous scale since it is not possible to take fractions of a move to solve the Tower of Hanoi problem, a line graph has been used to represent this data for the sake of clarity and consistency. The benefits of this form of presentation, as opposed to histograms

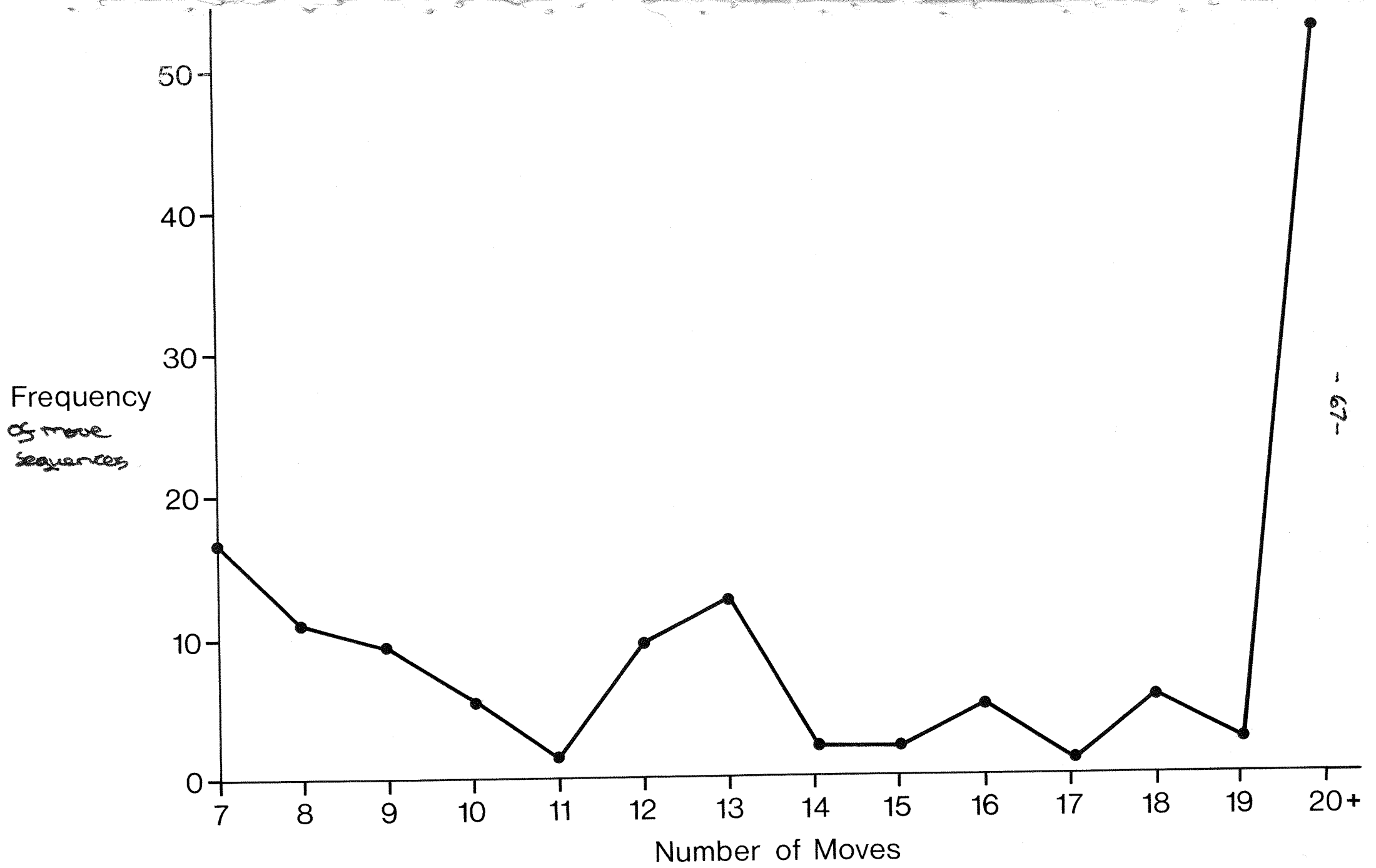

Figure 3.2 The Combined Pre-Test Score Distribution for Subjects from Both Training Conditions

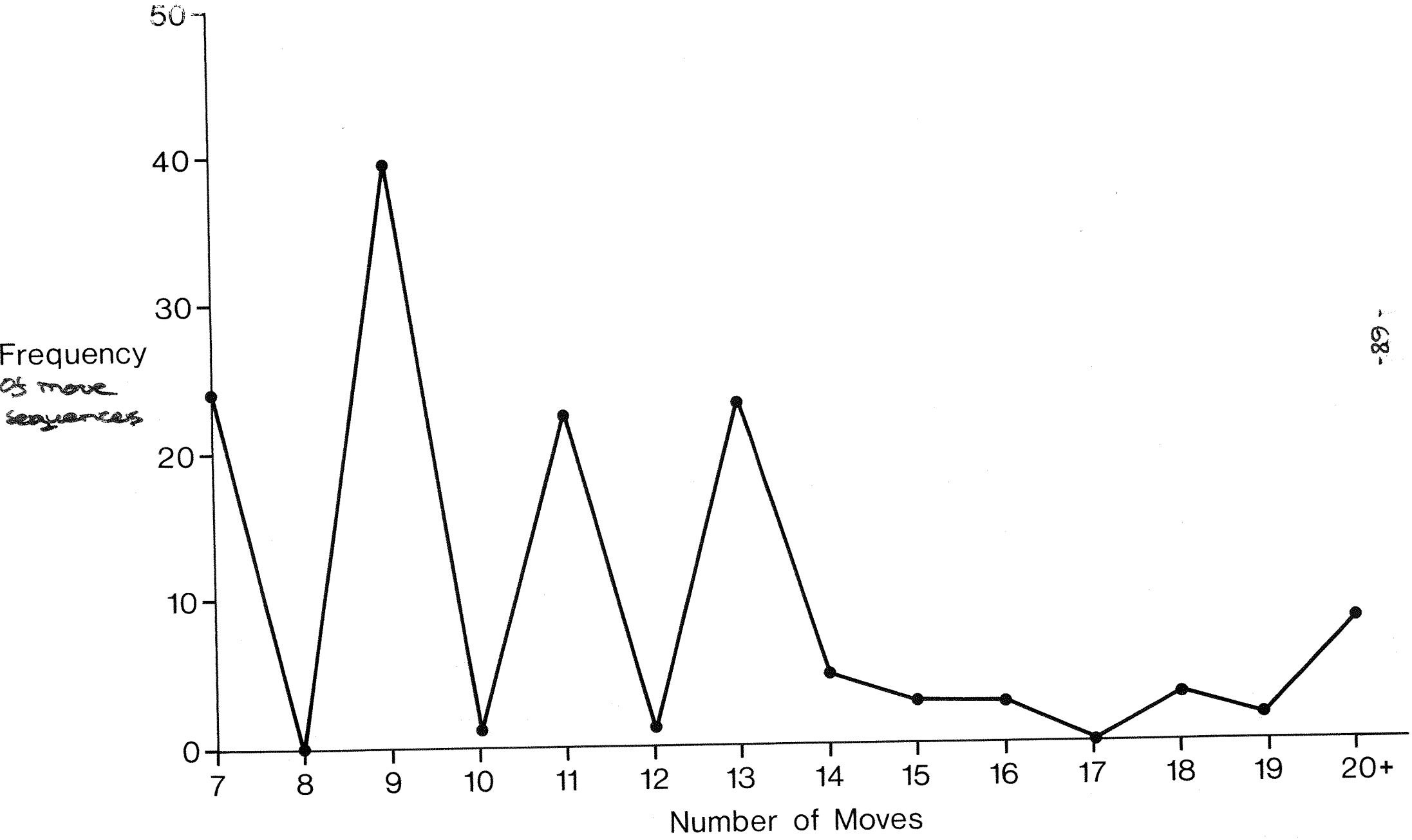

Figure 3.3 The Combined Post-Test Score Distribution for Subjects from Both Training Conditions

for example, become particularly apparent in later chapters when the group performances of subjects from different conditions are assessed and compared in a similar manner. Presentations of this kind were found to represent the data in the most visually clear and comprehensible form.

It is evident from the pretest distribution that, at this stage, subjects were overall not adopting any predominant strategy to solve the problem. In fact the most frequently occurring performance was where subjects failed to complete a 3 disc trial. Subjects who did solve the problems adopted many diverse methods to achieve this end requiring between seven and nineteen moves for their completion, but no one method clearly predominated over the others.

At post-test the number of instances of solutions requiring more than fourteen moves were substantially reduced. This probably reflects the general improvement in performance observed for nearly all subjects (95%)who on average took more than fourteen moves to solve the 3 disc problems at pre-test. Furthermore it is evident that subjects were now frequently utilizing one of the four strategies to solve the problem ; the most frequently occurring solutions taking seven, nine, eleven and thirteen moves. These strategies were clearly defined with subjects rarely incorporating false moves into their solutions (i. e. taking eight, ten, twelve or fourteen moves). It is apparent from the post-test frequency distribution of the number of moves required to solve the 3 disc problems that experience with this task results in subjects, of this age, developing clearly identifiable plans and strategies for its solution.

3.8 DISCUSSION

While subjects in all conditions showed a marked improvement in their performance those trained in the competitive social condition progressed significantly more than their peers trained individually. Furthermore the results for more and less advanced subjects suggested that the benefits of the interactive experience were only

for subjects, in the competitive condition, who already possessed at least partial understanding of the logic underlying the task.

Although the numbers are small the findings suggest that less advanced subjects were as likely to improve after an individual training experience as after a social experience. 95% of subjects who on average at pre-test had required more than fourteen moves to complete a 3 disc problem, improved their performance at post-test. These subjects were initially naive in their level of understanding of the problem showing little evidence of clearly defined methods or strategies and had generally approached the problem in a random manner. This finding is only partly in harmony with those of Mugny and Doise (1978). These authors found that interactions between non-conserving subjects were unproductive of cognitive reorganization. The findings presented here suggest that an interactive experience between two naive subjects is no more beneficial than a naive subject working alone, however, there is clear evidence that these subjects do progress. One possible explanation of these findings is that encounters between two naive subjects will not produce any conflict since neither are likely to express clear viewpoints. Perret-Clermont (1980) has expressed such a viewpoint arguing that naive pairs are unproductive of cognitive change since they are unaware of any conflict and that they must have attained at least a minimal developmental level for a specpfic ability, before they have the conceptual base to benefit from a confrontation. The progress made by these subjects in the present investigation may be primarily the result of trial and error approaches which can as easily occur individually as in exchanges with others.

The situation appears to be quite different when considering dyadic interaction between more advanced subjects in the competitive condition. For subjects, who on average took fourteen moves or less to solve the 3 disc problems at pre-test, social interaction, under certain conditions, appears to have been beneficial. These subjects, while not successfully solving the problem in the optimal

way at pre-test do not approach the task in a random manner. They entered the training situation already equipped with certain skills and understanding which determined their approach to the problem. The existence of partly or fully developed strategies within an encounter apparently enabled more constructive exchanges to take place within which several alternative approaches became apparent. While the pairs of subjects were matched for ability these intermediate subjects frequently fluctuated in the strategies they displayed in their attempts to achieve the most efficient solution strategy. In fact there were clearly several instances in which subjects were adopting different strategies in their attempts to win a game. As a result subjects frequently came into contact with alternative approaches to their own. It may be attempts to co-ordinate these different possibilities that result in individual's re-assessing their initial strategies and improving their performance along with their understanding of the problem.

The question of whether social interactions between two equals can be productive of cognitive change is somewhat confused. Mugny and Doise (1978) found that 50% of partially conserving children, in a spatial transformation task, who had been paired with other partial conservers made progress, while only 13% of non-conservers paired together progressed. However, there was no individual control group in this investigation and thus it is impossible to assess whether the progress made by the partially conserving children was significantly greater than one would expect of partial conservers working alone. Later Doise and Mugny (1979) found that spatial transformation skills could be better obtained by subjects who manifest an identical centration if they physically approached the task from opposite viewpoints, than by subjects who were individually confronted with a centration opposed to their own. Contrary to expectations, however, when considering nonconserving dyads and partially conserving dyads separately, it was only the former who progressed significantly more than their individual counterparts. Partial conservers manifested the same trend but did not approach significance. The findings reported here support the general proposal

that interactions between equals can facilitate cognitive reorganization. This is the case for both less advanced dyads and more advanced pairs, but it was only with the advanced subjects that this progress was significantly more marked than for a parallel group of individual subjects. The findings further support the view of Doise and his co-workers that the presentation of a 'correct' solution is not an essential element in a profitable interaction.

The differences observed in the success of the two social situations are perhaps best understood in terms of how the subjects' interpreted their roles in these different situations. In the co-operative condition it was apparent that subjects found it difficult to reconcile the instruction that they should work together with the rule that they had to take turns at moving the discs. They appeared to interpret the request to take turns as implying that each move was the exclusive concern of the individual whose turn it was. This frequently resulted in subjects working independently towards their mutual goal. This was clearly disruptive of any long-term strategies with subjects rarely disputing their partners' moves because it was their turn even when it was apparent that they were in disagreement. Thus, in several instances this condition resulted in only a few exchanges with subjects working more like individuals than a co-operative pair. No such confusion appeared to exist in the competitive situation which shares, in conjunction with many other games, the characteristic that both participants have different goals and have to attempt to outwit their opponent. The subjects were clearly experienced with this kind of game situation and taking turns appeared to be accepted as an appropriate means of tackling the problem. Generally both subjects paid close attention to their opponents moves in an attempt to thwart his efforts to win the game. This frequently generated disputes related to the state of play. The competitive situation overall appeared more successful at engaging both partners in an interactive situation and in creating the opportunity for the transmission and recognition of differing viewpoints.

In order to continue the main line of enquiry of this project in the studies which follow, it is proposed to consider more precisely the exact nature of the interaction situations within which subjects engage in their attempts to solve the Tower of Hanoi problem. The present findings have indicated that the Tower of Hanoi is largely a manipulative problem which elicits only a limited amount of verbal discussion and explanation, and furthermore it has provided some insight into the methods subjects adopt to solve this problem. Furthermore the discovery of specific solution strategies presents the possibility of an alternative assessment measure of performance. These issues will be further investigated in the following chapter.

CHAPTER 4

A STUDY OF THE EFFECTS OF COMPETITIVE AND CO-OPERATIVE SOCIAL EXCHANGES BETWEEN UNMATCHED DYADS ON THE INDIVIDUAL'S UNDERSTANDING OF THE TOWER OF HANOI PROBLEM AND AN ISOMORPH

4.1 INTRODUCTION

The first study considered how the task, as a medium within which one can examine the possible facilitatory effects of social interactions for individual understanding, may structure those interactions. The nature of one particular task and the limitations it imposed upon related social exchanges were discussed. Clearly, however, there were other factors which were also influential in determining the structure and outcome of exchanges between peers, such as the individual abilities of those involved and the instructions that they were required to follow. Furthermore it was not evident from the earlier investigation whether the different social training situations resulted in subjects individually adopting similar or qualitatively different strategies to solve the problem at post-test. The first study suggested several contentious issues and the design of the second study was, in part, the result of problems arising from the first.

One important finding arising from the first study was that the co-operative condition was not significantly more facilitative of performance than the individual condition. Since it was evident that this particular social situation elicited only limited co-operative behaviour, it was unclear to what extent co-operative activities generally are unproductive of improved performance. Was this finding simply due to subjects in this condition working somewhat independently of each other, or does collaborative performance on this task serve to disrupt any formulation of overall strategies due to each subject taking only partial responsibility for the solution?

To investigate this issue two small handles were added to each of the Tower of Hanoi discs. In an attempt to encourage mutually collaborative behaviour subjects were required to jointly pick up and move the discs, with each child holding one of the handles. This necessitated the co-ordination of the manipulative element of the task which, it was hoped, would further encourage other co-operative behaviours between the subjects. Thus this second study set out to devise a better structured co-operative situation and to investigate the individual benefits that may result from this condition.

A further issue arising out of the pilot study concerned the viability of accurately matching children according to their initial levels of understanding. In the first investigation symmetrical dyads were formed by pairing together subjects who had required a similar number of moves to complete the pretest trials. However, a post-hoc examination of these pairings revealed that it was unlikely that subjects in these dyads were in fact approaching the task in an identical manner. Subjects who on average took a similar number of moves over several pretest trials frequently exhibited wide discrepancies in their performance on each individual trial. Clearly subjects who initially approached the task in a random fashion cannot be matched according to the methods they utilized to complete the problem. Furthermore, subjects part-way towards an understanding of the problem did not adopt one consistent approach but exhibited apparent oscillations of strategy. This has also been observed by Doise and Mugny (1979) for partially conserving children working on a spatial transformation task. These observations suggest serious problems when attempting to imply a symmetry in the levels of understanding of two subjects based upon their overall pre-test performance. As a result subjects allocated to social training situations in this second investigation were randomly paired together. Evidently this procedure results in dyads reflecting varying degrees of asymmetry in the levels of understanding of their individual members. However, these pairs are different in an important way from those utilized in most asymmetrical modelling studies or by investigators observing active exchanges between conservers and non-conservers. In both of these situations one member of the dyad was fully conversant with the problem, while

in the present investigation both subjects possessed only partial understanding of the problem under consideration.

The likely asymmetry of the dyads, resulting from random pairings, means that any facilitation of understanding occurring as a result of interactive experience may be explicable in terms of several different mechanisms. Although both the modelling hypothesis (Botvin and Murray, 1975) and the social dominance hypothesis (Miller and Brownell, 1975) are generally applied to interactions where one partner is operational and the other pre-operational, the arguments may also be extended to all asymmetrical encounters. The work of Kuhn (1972) is an example of non-operational viewpoints being modelled by more naive children. Although no evidence exists to support a social dominance hypothesis for such interactions, one may suggest the possibility that as a child progressively develops his knowledge he becomes more assured of his viewpoint. Thus the viewpoint of the relatively more advanced member of any dyad may predominate due to his stronger belief in his position. Both of these arguments emphasise the role of the more advanced child's understanding in facilitating cognitive progress for his less advanced partner. Doise conflict hypothesis, however, would entertain the possibility that both members of the dyad may progress as a result of their social encounter. There are two possible outcomes which would dispel the possibility that individual progress is explicable solely in terms of a modelling or social dominance mechanism. One is that the less advanced child may progress beyond the initial level of his more advanced partner, and the other is that the more advanced child himself shows evidence of progress. Either or both of these outcomes would refute the possibility that the interaction was productive only in so far as a less advanced child encountered a more advanced viewpoint. The former suggests that the less advanced child has not simply adopted the position of his more advanced peer but has gained an insight which could not be derived as a direct result of his partner's level of understanding. This finding would imply a greater constructive role for the more naive child than would be suggested by a modelling or social dominance hypothesis. The latter outcome would again suggest a more important role for the less advanced member of the dyad since the more advanced

partner also benefits from their exchanges. It is important to emphasise that such findings would not exclude the possibility of a modelling or social dominance process occurring at some juncture during an interaction, but would clearly indicate that these were not the only elements of the encounter which facilitated changes in performance. It is therefore proposed to examine the ability of these alternative explanatory mechanisms to account for any progress occurring as a result of social training conditions.

In the first study it was evident that most subjects, at post-test, adopted clearly identifiable strategies to solve the 3 disc Tower of Hanoi problem. The four strategies that were established suggested a more qualitative means of assessing changes in performance resulting from a training experience. For convenience I will refer to the strategies according to the number of moves they require for their completion. It is possible to list the strategies in an ascending order of merit as subjects were requested to solve the problem in as few moves as possible. Thus the optimal strategy required only seven moves while the less efficient strategies needed nine, eleven or thirteen moves for their completion. In addition to these methods of solving the problem one can add those attempts which did not suggest an underlying method of strategy and also those instances where subjects failed to complete the task altogether. Thus, there are six clearly identifiable levels of performance for this problem. It is possible to examine the extent of performance change from pre to post-test by awarding +1 mark for each progressive step a subject makes towards the seven move strategy, and -1 for each regressive step away from this ideal solution. For example, a subject who at pre-test failed the problem outright but at post-test correctly solved the problem, using the seven move strategy, would be awarded an improvement score of +5. If the subject had regressed from the seven move strategy at pretest to adopting the eleven move strategy at post-test his score would be -2. Since subjects have to complete three trials at both pre and post-test it is proposed to describe their performance, at one of the six levels, according to their predominant method of solving the problem. Thus, if a subject

performed at one of these levels on at least two out of the three trials, that level will be regarded as the most representative description of his approach to the problem. A special case is one where a subject uses a different strategy on each of the three trials. Such a subject's mixed strategy performance will be described at the level of the middle strategy he adopted. Thus a child who utilized the nine, eleven and thirteen move strategies on successive trials will be allocated to the eleven move strategy performance level. This scoring procedure will be used alongside the assessment of performance according to the mean number of moves a subject requires to solve a series of problems. The use of this new assessment method may provide greater insight into the qualitative changes in performance that occur as a result of different training experiences.

This second study also utilized an isomorphic task of the Tower of Hanoi. This was in order to investigate if changes in individual performance, arising as a result of different training experiences, with the Tower of Hanoi problem, would also generalise to a parallel task. The isomorph was a game involving motor vehicles based upon a task devised by Luger (1979). It was comprised of three adjoining roads forming an inverted Y shape drawn on a large cardboard sheet and labelled A, B and C (see figure 4.1). Each road was made up of three clearly delineated coloured regions. Toward the extremities of each road were blue areas, in front of these, moving towards the junction, were yellow areas and finally in front of these red areas. Three cars, one blue, one yellow and one red, are placed upon their corresponding colour areas on one of the roads. The aim of the game is to move the cars to one of the other roads in as few moves as possible, moving only one car at a time with no overtaking permitted. Each car was only permitted to stop on those areas to which they corresponded in colour. This restriction was parallel to the rule of the Tower of Hanoi, which prevents one placing a larger disc upon a smaller one. The sequence of moves required to solve this problem correspond with those required to solve a 3 disc Tower of Hanoi problem, both tasks clearly being founded on the same mathematical principles.

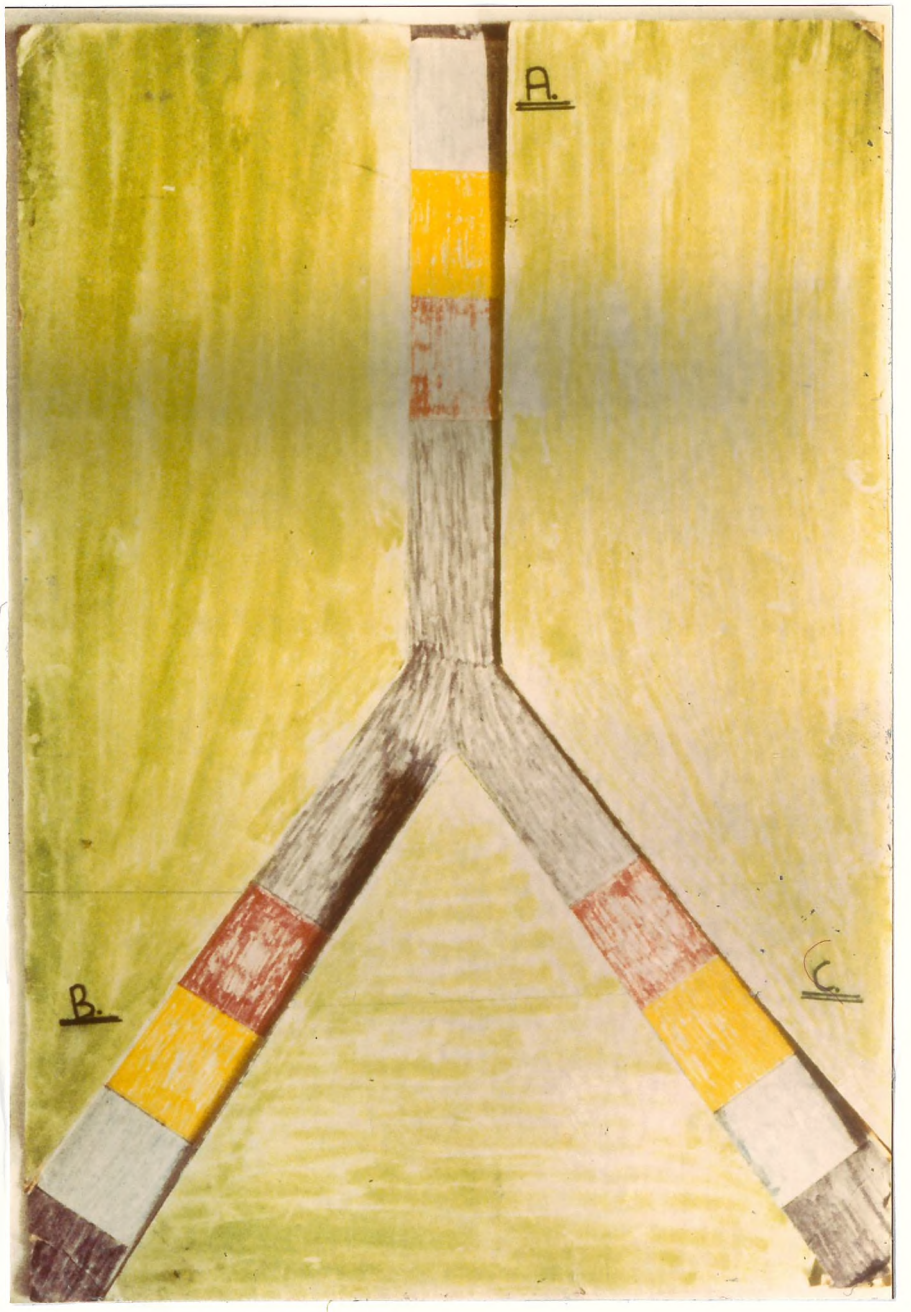

Figure 4.1 The Car Game

A further feature of this investigation arising directly as a result of the experience of the first study, concerned the number of trials comprising the training sessions. It was evident that subjects placed in a social situation required the opportunity to settle and relax into what was frequently a novel problem solving environment. To counteract this response the training sessions were extended from four to eight trials.

This study, therefore, had three major aims. Firstly, to investigate whether a co-operative interaction between peers can, under certain conditions, facilitate cognitive growth. Secondly, to examine the qualitative changes in strategic approaches to the Tower of Hanoi that result from different training experiences, and how these different experiences also relate to the individual's performance on an isomorphic task. Finally, to consider which explanatory mechanisms are best able to account for any observed changes in individual performance.

4.2 EXPERIMENTAL DESIGN

Subjects.

48 children, 20 boys and 28 girls, who were pupils at Romsey County Junior School acted as subjects. The mean age of the subjects was 8.6 years within the range 7 years 11 months to 9 years 2 months. The school was run on an open plan basis and encouraged group work in many of the children's activities. The catchment area of the school would generally be described as middle socio-economic class.

4.3 PROCEDURE

The experimental procedure was similar to that adopted in the first study again being divided into pre-test, training and post-test sessions. Once again these sessions were preceded by an informal meeting with each subject in order to establish a more comfortable and relaxed relationship with them. This informal meeting took the same form as in the previous investigation.

Pre-Test

The general format of these sessions was identical to that described for the first investigation and will not be reiterated here. The session was, however, extended in order to introduce subjects to the isomorphic car game. The order of presentation of the two pretest tasks was alternated. The car game, like the Tower of Hanoi, was first of all placed on a table between the subject and the experimenter. The board was described to the subjects and their attention was directed particularly towards the three roads, labelled 'A', 'B' and 'C'. The coloured regions were discussed being described as 'parking places' for their correspondingly coloured cars. The subjects were informed that each car was only permitted to stop on its own coloured areas and must never be left anywhere else. They were then directed to place the cars on their own appropriate areas on road A and were told that the problem was to try and move the cars from road A to one of the other roads. However, it was explained that they were only allowed to move one car at a time and that in no event was one car to overtake another. It was then re-emphasised that each car must always end up on one of its own special areas. There followed three trials, two from road A to road B and one from road A to road C. The end of these three trials completed the pre-test for the car game.

Training

As in the previous study three training conditions were used. One was an individual control condition and the other two were social conditions ; one co-operative and the other competitive. The subjects were randomly allocated to one of these conditions. In the social training situations subjects worked together in dyads which were again randomly formed from among the children allocated to these conditions. In this session subjects only worked with the Tower of Hanoi problem and not the car game.

The format of the training sessions was identical to that described for the previous study except for two alterations. Firstly,

as previously described, the training sessions were lengthened from four to eight trials. All trials still commenced from the centre pole and alternated between the two end poles. Secondly, the co-operative situation was altered in order to overcome some of the problems encountered in the first investigation. Subjects in this condition were now instructed to pick up and move the disc together. This was now possible as a result of the handles which had been added, as described earlier. Subjects, in this condition, were told that they had to work together in order to solve the problem, and that every time they wished to move a disc they both had to hold one of the handles having previously jointly agreed upon the move to be made. While the structure of the co-operative situation was altered the general instructions remained the same.

Post-test.

The individual post-test sessions with the Tower of Hanoi were identical in format to that described in relation to the first investigation. The sessions were, however, again extended in order to also permit individual post-testing on the isomorphic car game. This part of the session was a repeat of the pre-testing procedure with this task.

4.4 RESULTS

Figures 4.2 to 4.8 again represent the performance of subjects in a graphical form. Figure 4.2 shows a typical distribution for the frequency of different solutions occurring at pre-test to solve the 3 disc Tower of Hanoi problems. Figures 4.3 to 4.8 represent similar distributions for the performance of subjects, in each condition, during the training and post-test phases of the experiment. It is clear from these distributions that the number of instances of solutions requiring more than 14 moves (i.e. non-strategic solutions) were greatly reduced in all conditions from pre to post-test. However, at post-test subjects trained in either of the social conditions showed more clearly the use of well defined strategies than subjects trained individually. After competitive training subjects adopted the seven

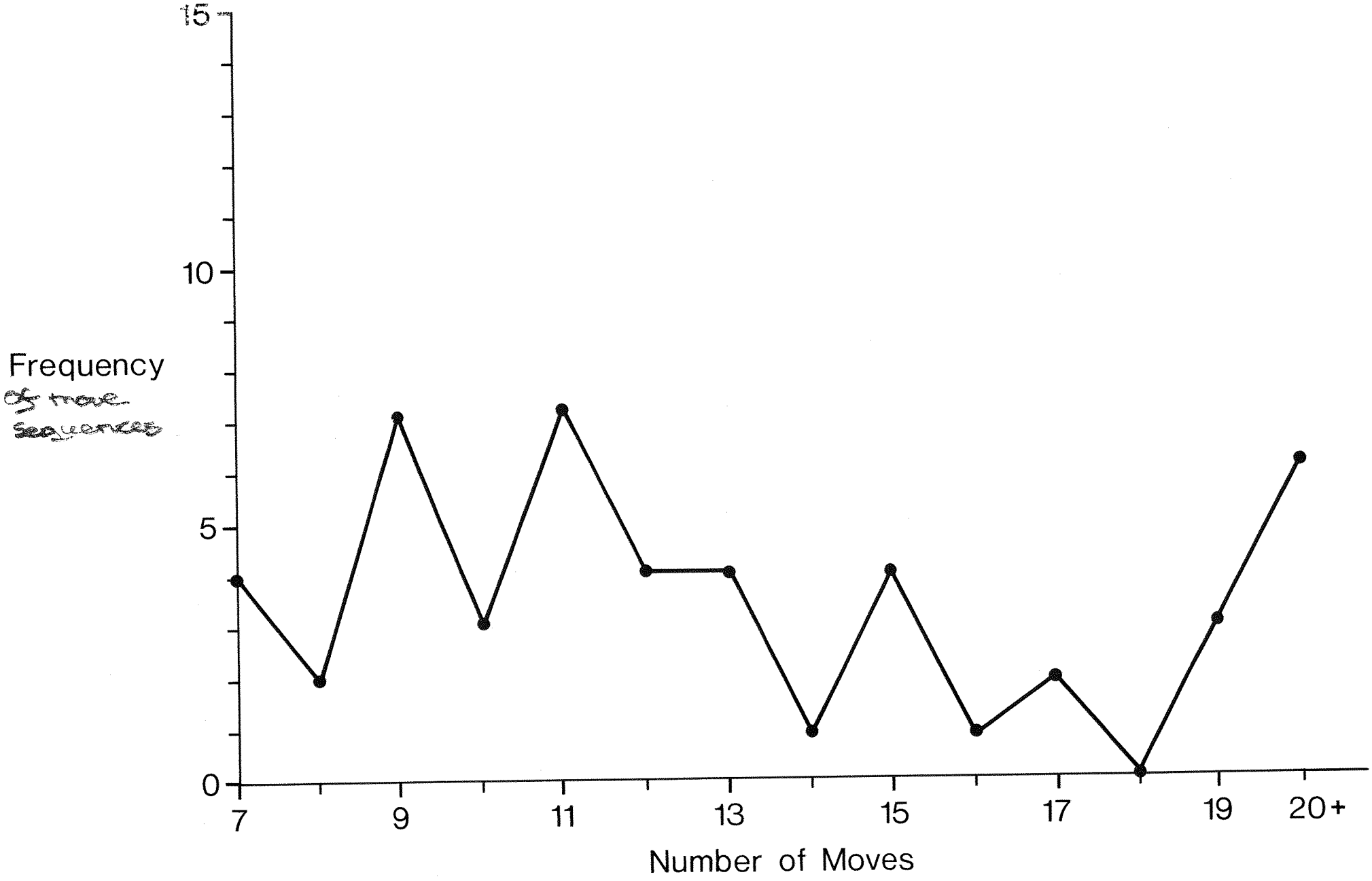

Figure 4.2 A Typical Pre-Test Score Distribution for the Performance of Subjects on the 3 Disc Tower of Hanoi Problems

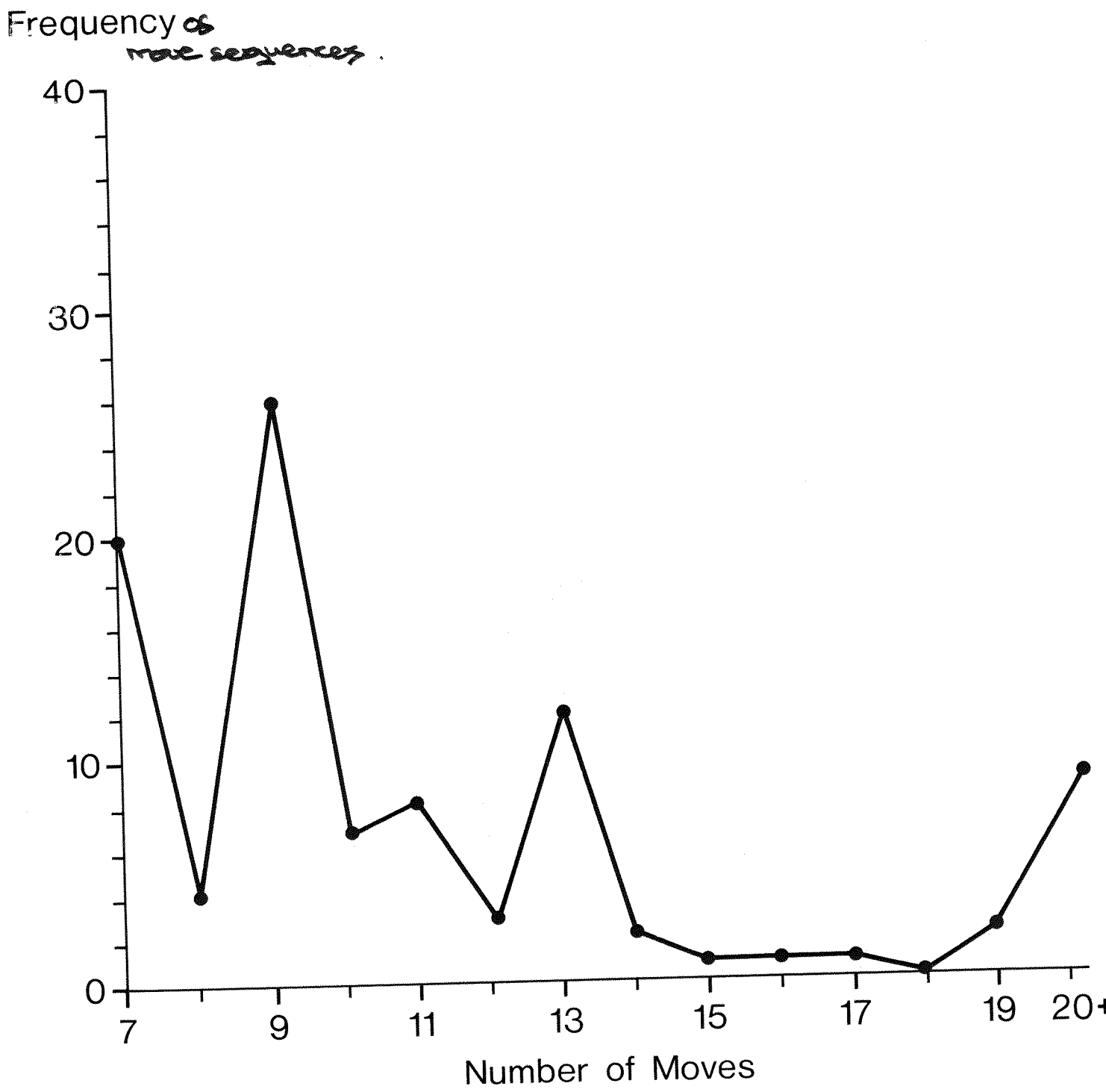

Figure 4.3 The Distribution of Scores During the Training Sessions of Subjects in the Individual Condition

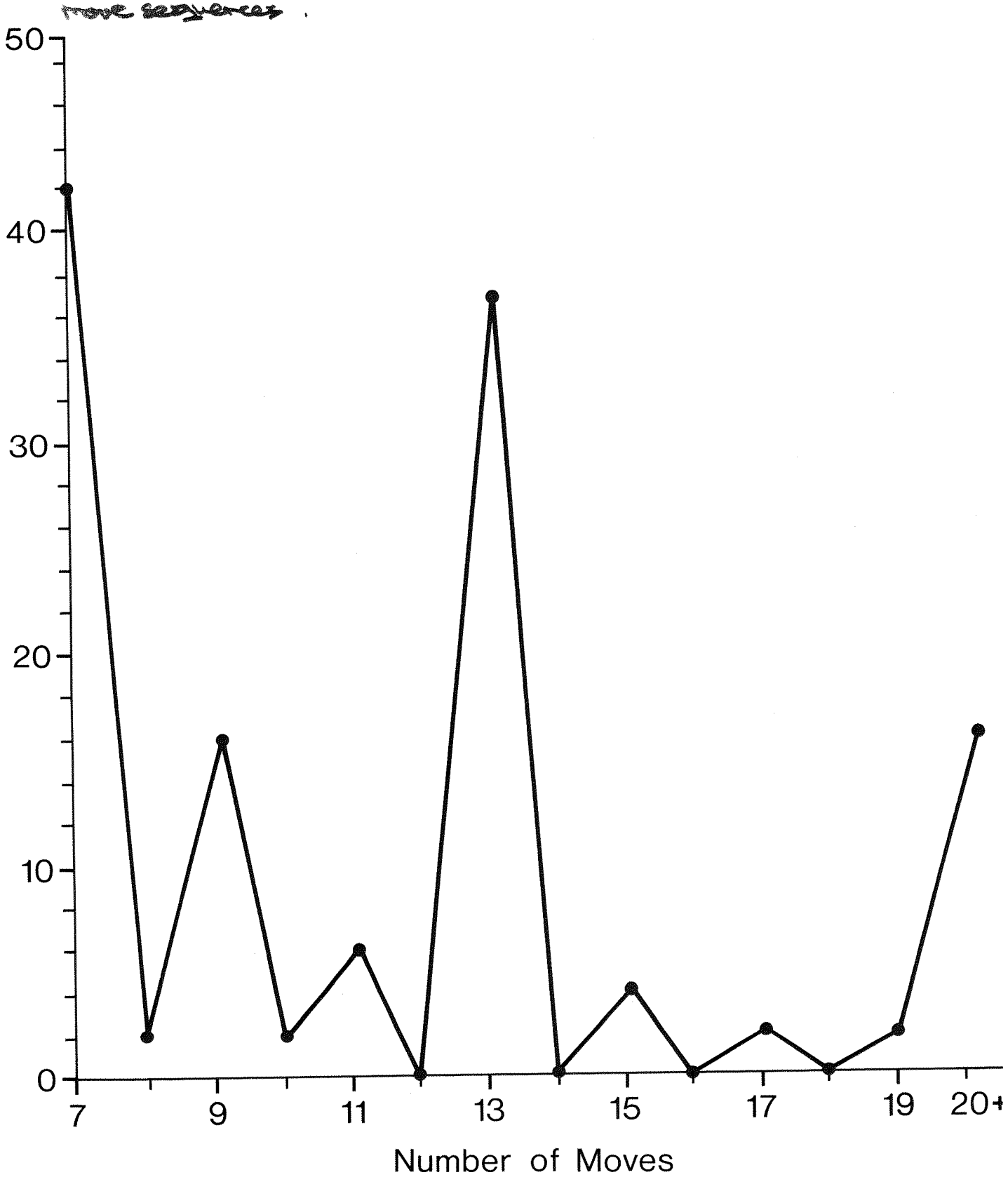

Figure 4.4 The Distribution of Scores During the Training Sessions of Subjects in the Competitive Condition

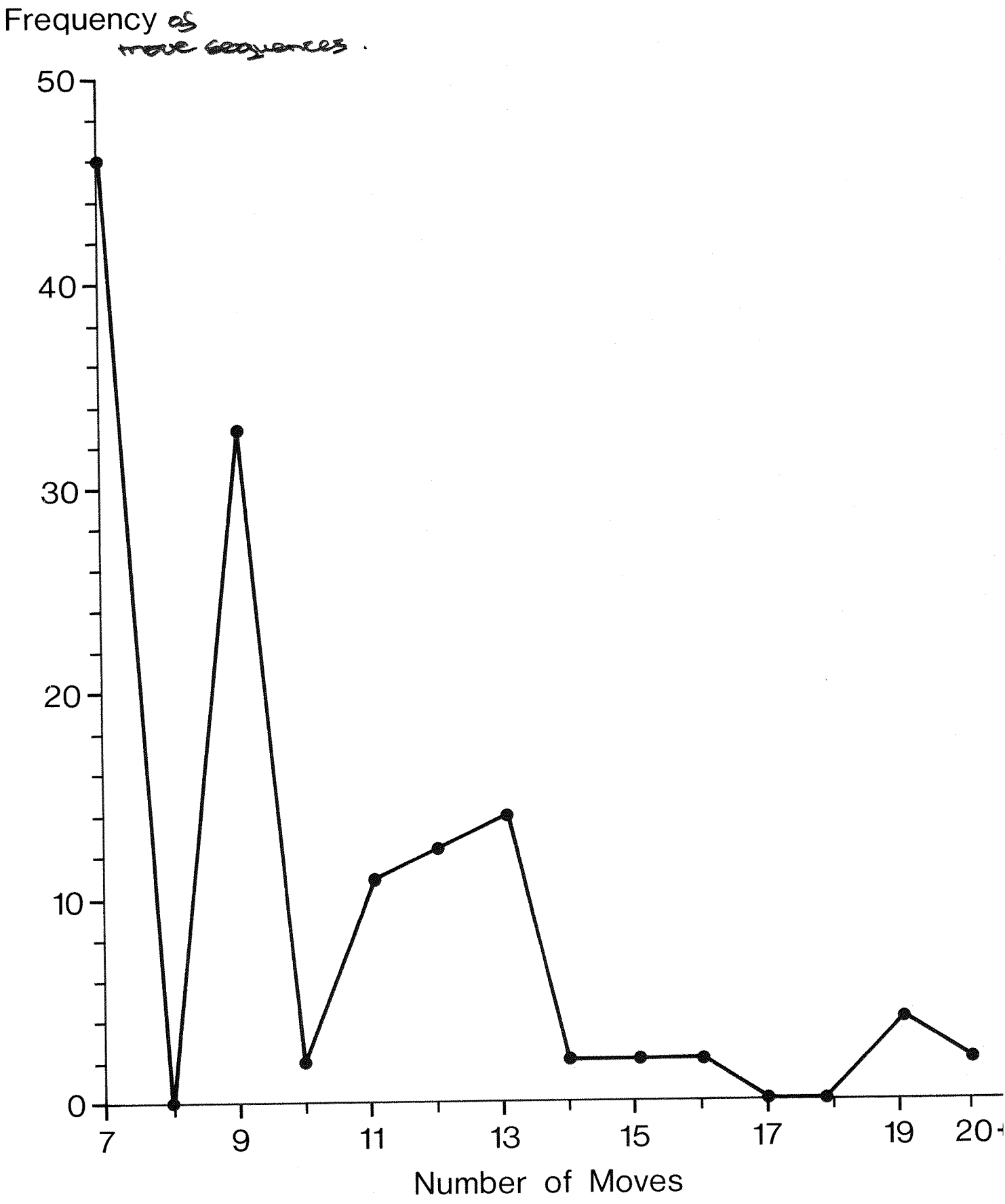

Figure 4.5 The Distribution of Scores During the Training Sessions of Subjects in the Co-Operative Condition

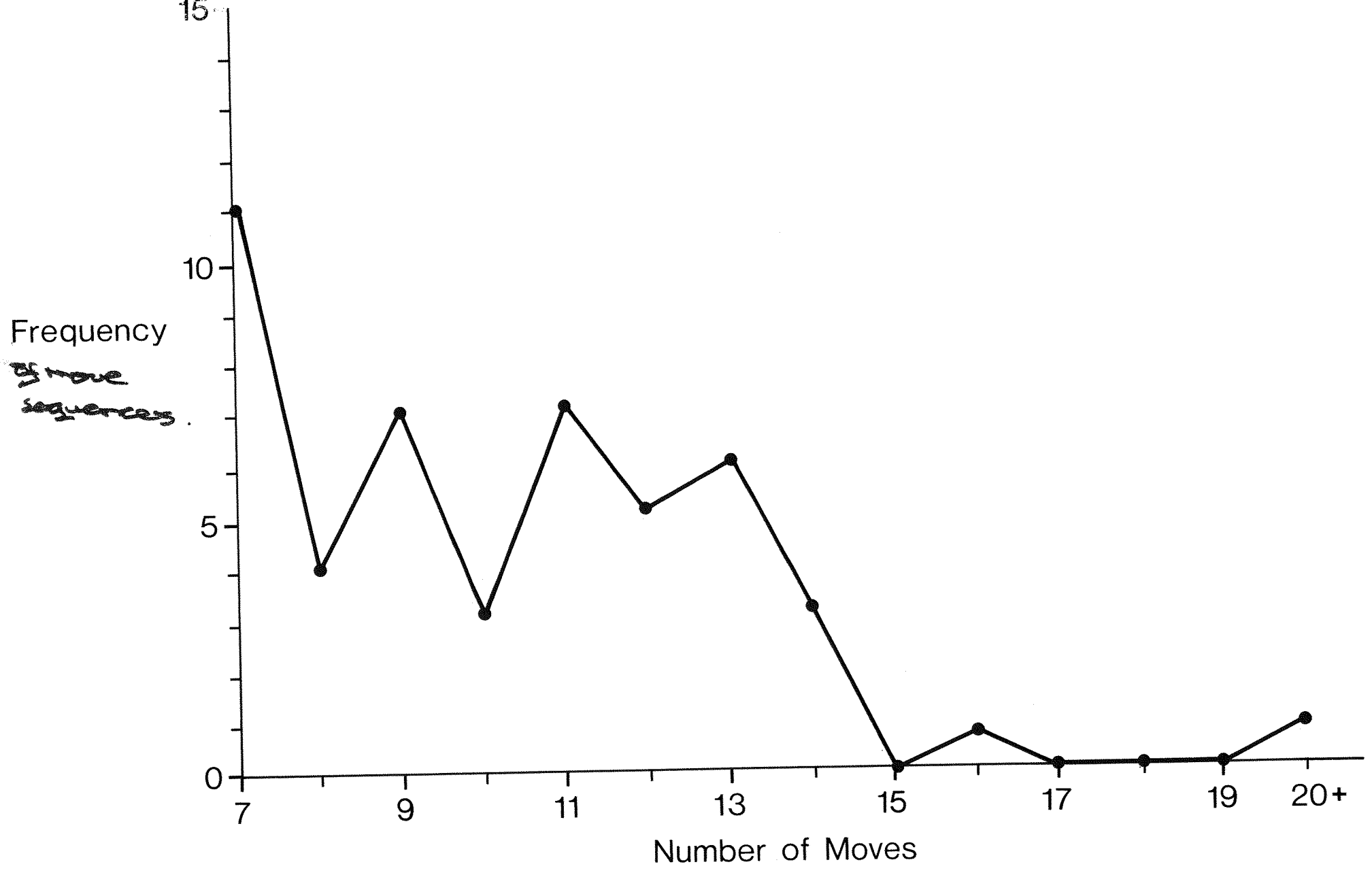

Figure 4.6 The Score Distribution for the Post-Test Performance of Subjects Trained in the Individual Condition on the 3 Disc Tower of Hanoi Problems

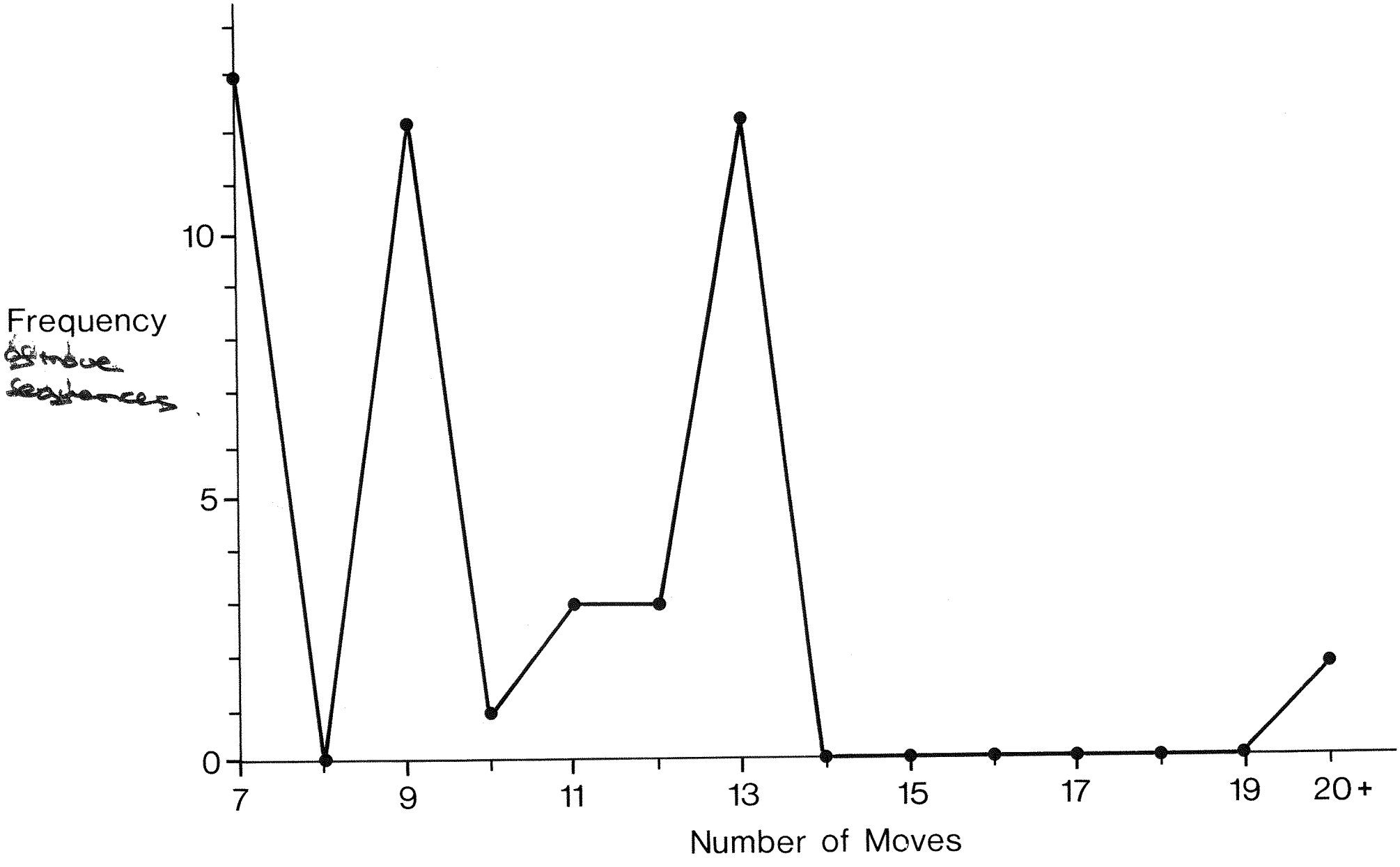

Figure 4.7 The Score Distribution for the Post-Test Performance of Subjects Trained in the Competitive Condition on the 3 Disc Tower of Hanoi Problems

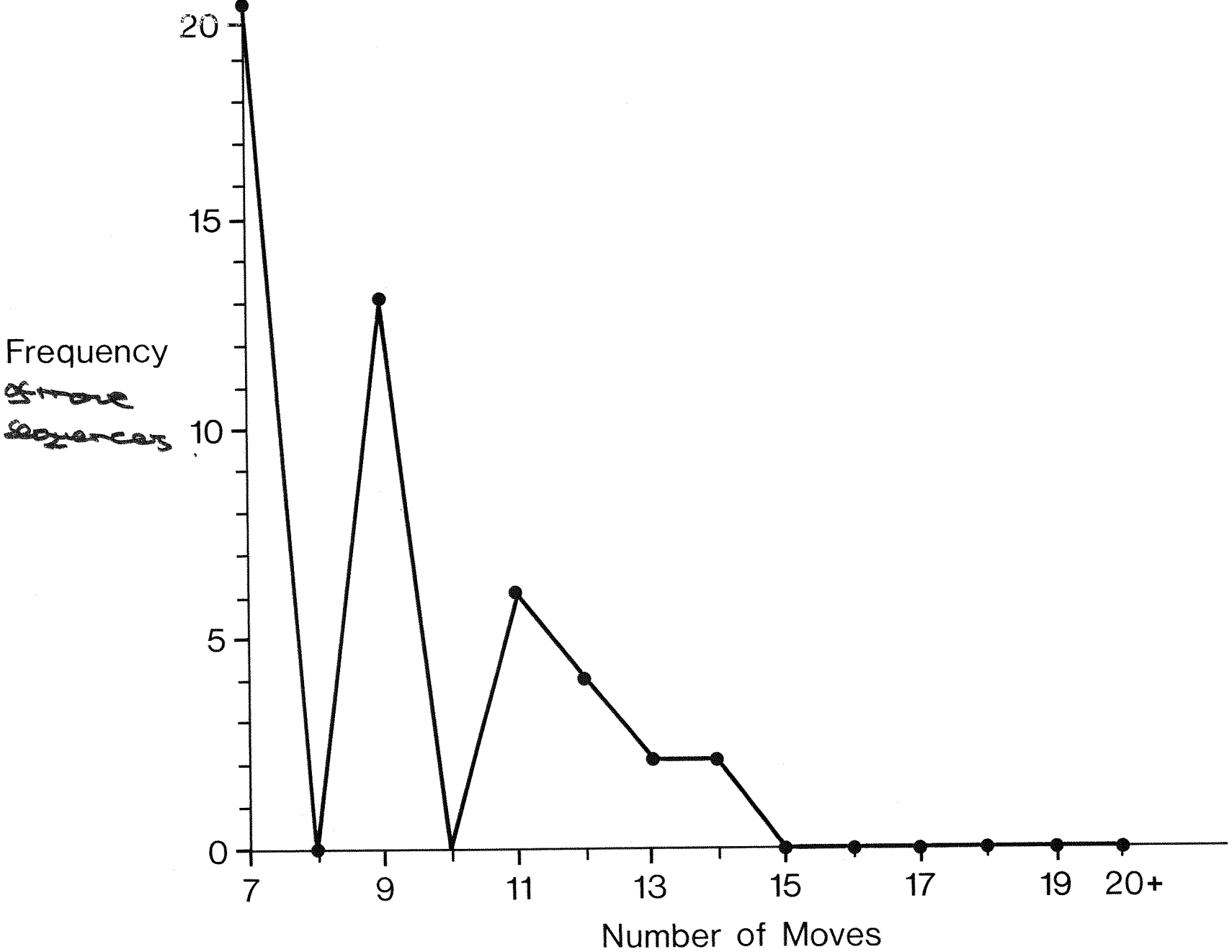

Figure 4.8 The Score Distribution for the Post-Test Performance of Subjects Trained in the Co-Operative Condition on the 3 Disc Tower of Hanoi Problems

move, nine move and thirteen move strategies with about equal frequency. Subjects in the co-operative condition, on the other hand, displayed a marked preference for the optimal seven move strategy although the nine move solution was also frequently observed. It is further interesting to note that the post-test strategy distributions for the different social conditions were closely parallelled by the frequency with which these strategies occurred during the corresponding training sessions. (See Figures 4.4, 4.5, 4.7 and 4.8).

Table 4.1 shows the number of subjects who improved their performance on the Tower of Hanoi problem for each condition from pre to post-test. Subjects in the co-operative condition were the most likely to progress (93.7%) followed by those in the competitive condition (81.3%) and finally subjects in the individual condition were the least likely to progress (56.0%). It is evident that all subjects who, on average, had taken more than 14 moves to solve the Tower of Hanoi pre-test problems, progressed irrespective of the kind of training they experienced. It was only for the initially more advanced subjects that the various training situations were differentially effective at evoking progress. These findings are very closely paralleled by those indicating the percentage of subjects from the different conditions who improved their performance on the car game (Table 4.2). The co-operative condition once again being the most effective with 87.5% of subjects progressing, while 75.0% of subjects trained in the competitive condition also progressed along with 56.0% of subjects trained individually. All subjects who on average took more than 14 moves to solve the car game at pre-test again showed evidence of improved performance at post-test.

Intra group comparisons of performance at pre and post-test on the 3 disc tower problems, revealed that overall subjects in both the co-operative ($t = 4.08$, $p < 0.01$) and competitive ($t = 3.60$; $p < 0.01$) conditions showed significant improvement in the number of moves they required to solve these problems. This was not the case for those subjects trained individually ($t = 2.05$). Significant progress was observed for the less advanced subjects after all

Table 4.1

The Percentage of Subjects who Progressed from each Condition Between Pre and Post-Test, for the 3 Disc Tower of Hanoi Problem; Assessed by the Mean Number of Moves they required to Solve the Problem.

condition / mean pre-test score range	Individuals		Co-operatives		Competitives		% age who progressed from each score range
	+	-	+	-	+	-	
8-14	3	7	8	1	7	3	62.1%
14+	6	0	7	0	6	0	100.0%
TOTAL	9	7	15	1	13	3	-
%age who progressed	56.0 %	44.0 %	93.7 %	6.3 %	81.3 %	18.7 %	-

Table 4.2

As above, for the Isomorphic Car Game

condition / pre-test mean score range	Individuals		Co-operatives		Competitives		%age who progressed from each range
	+	-	+	-	+	-	
8-14	4	7	10	2	6	4	60.6%
14+	5	0	4	0	6	0	100%
TOTAL	9	7	14	2	12	4	-
%age who progressed	56.0 %	44.0 %	87.5 %	12.5 %	75.0 %	25.0 %	-

where + indicates progress, and - indicates failure to progress

training conditions (Co-operative t= 5.16 ; $p < 0.01$), Competitive t = 3.66; p 0.05; and Individual t = 3.26 ; $p < 0.05$). However, progress was only observed for the more advanced subjects who had been in the co-operative condition (t = 2.99 ; $p < 0.05$).

A 1 way ANOVA across all conditions revealed no group differences in the number of moves subjects required to complete the 3 disc trials at post-test (F = 2.86). Dividing the subjects into the more and less advanced categories according to their pre-test performance showed no conditions difference for the less advanced subjects (F = 2.01), but for the more advanced subjects condition differences were found (F = 3.51 ; $p < 0.05$). Inter group t tests for these subjects showed that those trained in the co-operative condition performed significantly better at post-test than those trained individually (t = 2.13 ; $p < 0.05$). No significant differences were found between the performance of subjects in the co-operative and competitive conditions (t = 1.41) nor between the competitive and individual conditions (t = 1.82).

Considering the same group comparisons but using the observed changes in subjects' strategies from pre to post-test as the performance measure, overall significant group differences were found (F = 4.87 ; $p < 0.05$). Inter-group t tests revealed an overall significant benefit for subjects trained in the co-operative condition when compared with subjects in the individual condition (t = 2.06 ; $p < 0.05$). Once again no significant conditions effects were found when only considering the initially less advanced subjects (F = 2.94). However, significant group differences were again observed for the initially more advanced subjects (F = 3.54 ; $p < 0.05$). Both the co-operative (t = 2.51 ; $p < 0.05$) and the competitive (t = 2.19; p 0.05) conditions facilitated improved performance to a greater extent than the individual condition. No differences were found between the performances of subjects trained in the two social conditions (t = 0.98).

Significant conditions effects were also found for the number of moves the advanced subjects required at post-test to complete the trials on the car game (F = 3.67 ; $p < 0.05$).

Advanced subjects in both the co-operative ($t = 3.58$; $p < 0.01$) and competitive ($t = 2.19$; $p < 0.05$) conditions were found to generalise their understanding of the Tower of Hanoi problem to the isomorphic car game significantly better than similar subjects trained individually. No group differences were found for the performance of the less advanced subjects on this task ($F = 1.42$).

In five out of eight competitive pairs and six out of eight co-operative pairs, it was found that both members of the dyad individually used more advanced strategies to solve the Tower of Hanoi problems at post-test than they did at pre-test . Thus in the majority of cases, in both social training conditions, the more advanced member of a dyad showed evidence of progress along with his less advanced partner. Furthermore in six out of eight co-operative dyads the less advanced partner progressed to a level beyond the initial level of performance of his more advanced peer. This was also found to be the case in four out of eight competitive dyads. A comparison of the extent of strategy improvement for the initially more advanced members of the co-operative dyads with a matched group of subjects from the individual condition, revealed significant benefits as a result of the social experience ($t = 2.2$; $p < 0.05$). Similar benefits were also found for the initially less advanced members of the co-operative dyads ($t = 2.4$; $p < 0.05$). The same comparisons between subjects trained in the competitive condition and matched groups of individually trained subjects revealed no significant differences.

4.5 DISCUSSION

In considering the implications of these findings I shall consider the changes in performance observed for the less advanced subjects separately from those occurring for their more advanced counterparts. While only the social training situations produced significant improvements for their members as a whole, all training conditions were able to evoke cognitive progress for the less advanced subjects. Table 4.1 indicates that all subjects, who had

shown at least some signs of random behaviour in their attempts to solve the pretest problems showed evidence of progress at post-test, independent of the nature of the training they received. This improvement in performance is also reflected in the post-test distributions (figures 4.6, 4.7 and 4.8) which reveal very few examples of non-strategic solutions by subjects in any of the conditions. It appears that those subjects who initially showed no obvious organisation in their approaches were able to develop more structural strategical approaches simply as a result of the opportunity to practice upon the task. This again suggests some kind of a trial and error mechanism which, over time, enables such subjects to dispense with clearly unproductive moves.

These results are clearly supportive of similar findings presented in the previous study. They suggest that the transition from a random to an organised approach to this problem is not specifically aided by social exchanges with another. This is best understood in terms of the conflict model of behaviour change according to which social experience is efficacious only to the extent that conflicts of opinion arise during which individuals propose and defend discrepant viewpoints. Subjects not having a well defined viewpoint of their own are clearly less likely to oppose their partners suggestions nor are they likely to confront him with alternative strategies. Furthermore their naive perspective may create difficulties for them in understanding alternative viewpoints expressed by their partner. Thus naive individuals are unlikely to be able to enter into a meaningful interaction and are consequently less likely to experience and recognise conflict during interactions than their more advanced counterparts.

The situation is quite different when one considers the effects of the various training procedures on the performance of the more advanced subjects who exhibited evidence of strategic approaches to the problem at pre-test. For these subjects there were clear benefits derived from a social training experience as compared with an individual training experience. Both the co-operative

and competitive situations were found to facilitate individual performance more than the non-social training condition. The co-operative situation was the most successful. It engendered significantly greater progress than the individual condition whether performance was assessed by the number of moves subjects required to complete the post-test trials, or by the improvement subjects showed between pre and post-test in relation to the strategies they used. Subjects trained in the competitive condition only indicated significant improvement in performance relative to the subjects trained in the individual condition as assessed by strategy improvement. Clearly these findings suggest that social interactions offer particular benefits for these subjects. Once again these observed changes in performance are best understood in terms of socially encountered conflict. It is evident that conflict can only arise when two discrepant viewpoints are expressed and recognised and obviously this is most likely to occur in instances where the participants have at least a minimal level of understanding of the problem under consideration. As Doise 'conflict' hypothesis suggests when two individuals centre on different aspects of a problem they will experience a conflict of viewpoints which they will attempt to co-ordinate and this may act as a catalyst for cognitive change.

The findings of this study support the conflict model of cognitive change and suggest serious limitations to the alternative views which emphasise the role of the more advanced child in aiding his more naive partner. The data suggests that the greater knowledge of the more advanced child is not the determining feature of the observed improvements in performance. There were several instances in which the less advanced member of a dyad progressed <u>beyond</u> the initial level of understanding of their more advanced partner. Furthermore, there was also evidence of the more advanced members of the dyads deriving benefit from their interactions with their more naive parnters. These outcomes cannot be accounted for in terms of a modelling or social dominance hypothesis, which would predict that the less advanced partner would adopt the position of his more advanced peer who would himself not gain from encountering a

conflicting but less advanced position. It appears that we must attribute a more important and constructive role to the less advanced partner than is suggested by either of these hypotheses. It was demonstrated that the more advanced members of the co-operative dyads showed significantly greater improvement in their performance than a matched group of subjects trained individually. The trend was similar for subjects trained in the competitive situation although it was not significant. This suggests that exposure to a conflicting but less advanced viewpoint can actually facilitate improved understanding beyond that which would be expected if the subject worked alone. These findings further demonstrate that two individuals both of whom possess only partial understanding of a problem can improve that understanding in the absence of the correct viewpoint. Only the conflict hypothesis can accommodate findings of this nature.

Both social training conditions established the use of precise and clearly defined strategies at post-test, although these were qualitatively different for each condition (see figures 4.7 and 4.8). The overall performance of subjects at post-test who were trained in the co-operative and competitive conditions corresponded closely to their overall training experiences. Peers engaged in competition with each other frequently completed the trials in seven or thirteen move sequences (see Figure 4.4). Later when individually confronted with the task, at post-test, these same strategies were again frequently observed although the nine move strategy was also evident on several occasions. These three strategic approaches were very clearly defined with subjects rarely making an error in their execution. Thus there were no examples of eight or fourteen move solutions and only one instance of a ten move solution (see figure 4.7).

Subjects trained in the co-operative condition reflected a different emphasis in the strategies that they adopted during the training and post-test sessions from their peers trained competitively. During collaboration the most likely strategy to be observed was the optimal seven move solution. The nine move strategy also occurred on several occasions. Outside of these solutions there were few examples

of less advanced approaches to the problem (see Figure 4.5). At post-test individuals trained in this condition still maintained the seven move strategy as the dominant mode of solution with the nine move strategy also being frequently utilized. Again these strategies were well established. There were no instances of subjects making a performance error and thus requiring eight or ten moves to complete a trial (see Figure 4.8).

Subjects trained in the individual condition did not portray the same refinement in their methods of solving the 3 disc problems during training or at post-test. Subjects in this condition showed a tendency to adopt the nine move strategy during training although several other means were also apparent (see Figure 4.3). At post-test all four strategies occurred with about equal frequency. However in the performance of these strategies subjects frequently made errors which were reversed, resulting in several instances of eight, ten, twelve and fourteen move solutions (see Figure 4.6). These errors reflect a hesitancy and uncertainty in the performance of these subjects which was not apparent in the final solutions of subjects trained in social situations.

The major qualitative difference in the post-test performance of subjects trained in the two social conditions was the frequent use of the thirteen move strategy by subjects trained in the competitive situation. The co-operative training condition was more successful at evoking the most efficient strategies, while the competitive condition frequently evoked the most complex and least efficient strategy. The explanation for the frequent occurrence of this inefficient strategy may lie in the nature of the competitive situation itself. In this condition each subject was instructed that he must attempt to move the 3 discs to his own allotted pole in order to win the game and thus to prevent his partner from achieving a similar end. This may have resulted in subjects generally attempting to move discs on top of their own pole or, if this was not possible, at least not to move them to their partner's pole. This approach can be seen as much as an attempt to thwart one's partner's opportunity of winning as

an attempt to win onself. This may be a fine but important distinction. If one member of a pair started the game with an incorrect first move and henceforth both participants always tried to move only to their own goal pole or to the intermediary pole then a thirteen move solution would result. In fact the winner's second last move must be to his partner's pole but by then he may clearly be able to see how he can win the game. Likewise a similar strategy would result in a seven move solution if the opening move of the game was correct. Thus the large numbers of seven and thirteen move solutions observed during competitive games may be, at least partially due to subjects attempting to prevent their partner winning. In this situation subjects are in a conflict position between trying to win and attempting to do so in the most strategically efficient manner. As a result subjects may possibly be less willing to risk the unknown outcomes of trying new approaches and may maintain inefficient strategies so long as they produce the desired end result of winning.

The structure of the social situation was quite different for subjects trained in the co-operative condition who attempted to co-ordinate their ideas in order to reach a solution. In this situation there was no obvious factors restricting joint innovative attempts to improve performance strategies for the task. It was apparent that the co-ordination of the manipulative element of the task created a far more effective collaborative situation than was the case in the previous investigation. Co-operative behaviour of this kind was clearly condusive to the development of more efficient strategies to solve the problem. The co-ordination of action in this situation resulted in many individual subjects later performing the task in the optimal way. The different performances of subjects in these two conditions reflects the importance of the instructions given to them and the way in which these may structure the interaction situation and influence the resulting strategies adopted to solve the problem. The manner in which the experimenter dictates the structure of a social situation and the influence of this structure on the facilitatory aspects of peer interaction is an issue which will be further considered in the next chapter.

An important aspect of the improved performance of the more advanced subjects, as a result of a social experience, was that it generalised to a parallel problem. These subjects, whether trained in a co-operative or competitive situation, were able to generalise their performance better at post-test to the isomorphic task than similar subjects trained individually. However, one cannot conclude that the cognitive change occurring as a result of such experience is necessarily different in kind to that resulting from individual practice. The improved performance on the isomorphic task may not reflect a wider more general understanding of the underlying logic of the Tower of Hanoi problem, but simply a direct transfer of improved performance on one task to another identical in structure. This argument is supported by the finding that there was no observed difference in performance on the isomorphic task for the less advanced subjects whether trained in a social or individual condition. All of these subjects improved their performance on the Tower of Hanoi problem and were equally successful in their attempts to solve the isomorphic task. Evidently the different training conditions had not differentially affected the ability of these subjects to generalise their improved understanding. Only when comparing groups of advanced subjects who progressed on the Tower of Hanoi problem (as a result of a social training condition) with a similar group who did not show such progress (as a result of individual training) were differences in performance also observed on the isomorphic task. The issue of the extent to which different training procedures induce generalised understanding is an important one and will again be considered in later chapters.

The findings which have arisen from this investigation again support the general proposal that peer interaction can facilitate cognitive reorganisation. They suggest that the external limitations imposed by the experimenter upon the social environment in which the interactions take place may be an influential factor in structuring those interactions which in turn may produce qualitatively different approaches to the problem being examined. A situation which encourages mutually collaborative behaviour between the interactants has been demonstrated to be a particularly effective social setting within

which understanding can develop. It has been suggested that the progress resulting from these social encounters cannot be explained simply in terms of a subject being exposed to a more advanced viewpoint and that the less advanced partner may play a more important role in the interaction than has generally been suggested. The experience of cognitive conflict as a result of encountering alternative viewpoints has been proposed as one possible explanation for the observed improvements in performance. In the next chapter the role of conflict will be examined more closely and in particular the question of whether socially encountered conflict is a necessary or sufficient condition for cognitive reorganization will be investigated.

CHAPTER 5

THE ROLE OF CONFLICT IN PEER INTERACTIONS

5.1 SOCIALLY ENGENDERED CONFLICT : A NECESSARY OR SUFFICIENT CONDITION FOR COGNITIVE GROWTH

The two investigations discussed so far support the contention that peer interaction can facilitate cognitive growth particularly when subjects possess at least minimal competence for the task, being able to enter into a socio-cognitive interaction. It has been suggested that cognitive conflict experienced during these encounters may be a critical element in bringing about such change. However, it is uncertain if socially encountered conflict is a sufficient condition by itself to incite the observed changes in performance. For instance, it has been demonstrated that the extent to which an interaction between peers is conducive to the development of understanding is partly dependent upon the structure of the social situation imposed by the experimenter. It is unclear, however, to what extent these different situations evoke different degrees of conflict or whether they differentially fulfil other conditions which are also necessary for the facilitation of improved performance.

In an attempt to examine this issue I shall begin with a general consideration of some of the functions social situations may serve for the child. An analysis of this kind can suggest some features of the social situation which may be particularly important in determining whether an interaction is constructive, in the sense of being formative of new values, attitudes, understandings and so on. These features will then be considered in the light of how they may interact with socio-cognitive conflict arising between peers.

Social comparison theories have been concerned with the basis on which individuals or groups evaluate their conditions and experiences. Festinger (1954) suggested that other people are utilized as information sources where there is no physical reality against which one is able to assess the validity or worth of beliefs or values. Similar ideas have been expressed by Deutsch and

Gerard (1955), Homans (1961) and Kelly (1952), and all implied that in a social situation the group or other people serve as comparative and normative standards against which the individual can assess his subjective experiences. The group also serves an informational function, in that it is against its consensus that the correctness of beliefs and attitudes are judged. It can, of course, be argued that even physical reality is anchored in social consensus and dependent upon social validation. This view, for example, is reflected in the general theme of Baldwin (1908) that the acquisition of knowledge is not a solitary experience because the world of knowledge is social and other people sustain the truth of our judgements. The general idea is that we are dependent on others for information and validation of our experiences. However, this formulation does not address the question of the choice of the person or group selected as reference. Jones and Gerard (1967) suggested two categories : - the expert and the co-oriented peer , each of whom serves a different function. The expert informs the individual about how he may move from one state to another, while the co-oriented peer acts as the basis for the evaluation of the satisfactoriness of the present state. The work presented so far in this thesis suggests that peers may also aid in the re-assessment of an existing state.

Holmes (1976) drew attention, in a discussion of value, to an important factor in understanding the relationship between the growing child and the social system, and also to the nature of demands that society places on the growing child. He suggested that values are assumptions that people hold of what ought to be. The assumptions are asserted on the basis of a mysterious source ; - authority. Authority, for Holmes, is that which those more powerful than ourselves believe in. He suggests two forms of social organization associated with two different systems of socialization. One is based on the idea of the imposition of one will upon another by an authority figure who determines the accepted norms. The other is based on the interaction between peers in relationships of use, within which the child will construct the norms.

This view is clearly similar to the early position of Piaget

(e.g. 1932). He also characterized adult-child interactions as asymmetrical, being ultimately dependent upon relations of authority while he regarded peer interactions as more symmetrical. In his early writings Piaget gave a critical role to social experience in the achievement of operational thinking (e.g. Piaget, 1928, 1932, 1950). He argued that consciousness of one's own reasoning processes arises from the disposition to prove and justify to others what one has asserted, and that to do this one must reflect critically upon one's own reasoning with the eyes of an outside observer :

> "The social need to share the thought of others and to communicate our own with success is at the root of our needs for verification. Logical reasoning is an argument which we have with ourselves, and which reproduces internally the features of a real argument". (Piaget, 1928, p.204).

Piaget emphasised the role of the child's interactions with his peers in this context. Only with his peers, Piaget argued, could the child begin to solve the apparent contradictions between different viewpoints. Piaget emphasised the co-operative nature of these relations which he characterized by their equality and mutual respect :

> "Co-operation alone leads to autonomy. With regard to logic, co-operation is at first a source of criticism, thanks to the mutual control which it introduces, it suppresses both the spontaneous conviction that characterizes egocentrism and the blind faith of authority. Thus discussion gives rise to reflection and objective verification .... It leads to the recognition of the principles of formal logic". (Piaget, 1932, p.410).

Piaget's original observations concerning the significance of peer interactions were made in the context of discussions of perspective-taking and moral judgement, so that it is not surprising to find reference to his thesis in these fields of study. Both in the field of moral development (Hoffman, 1970) and in the field of perspective-taking (e.g. Light, 1979) recent attention has, however,

focussed primarily upon parent-child relationships as an influence upon development. Piaget's emphasis upon reciprocity, and his claim that this could only arise between individuals who considered themselves equals have not been rejected, but emphasis has been laid upon the capacity of the parent to interact with the child on the basis of a consciously constructed equality. Clearly it is the equality within these encounters which is of particular importance.

Thus it may be that in the absence of a dominant figure, where children are in command, master of their materials, and sure of what they are doing that they are less likely to be inhibited about expressing their own viewpoints or in attempting to formulate knowledge for themselves. An important element of these situations appears to be that the children have a degree of control and influence over the direction that events take. This is clearly absent in the presence of a dominant figure. Having created a situation in which children can at least partially determine the structure of the social situation, Piaget has further stressed the need for the child himself to have the opportunity to elaborate new information and has warned of the limitations of simple instruction or presentation of such information :

> "in other cases the gifts of instruction are presented too soon or too late, or in a manner that precludes assimilation because it does not fit in with the child's spontaneous constructions. The child's development is impeded, or even deflected into barreness, ... but there is a much more productive form of instruction .... to create situations that, while not 'spontaneous' in themselves, evoke spontaneous elaboration on the part of the child, if one manages both to spark his interest and to present the problem in such a way that it corresponds to the structures he has already formed himself".
>
> (Piaget, 1962, cited in Barnes, 1976, p. 80-81).

Piaget here emphasises the level at which information is presented to the child and also the opportunity for the child to develop

the information for himself. During an interaction between children one element that may evoke the need for elaboration is when a child is faced with a disjunction between his implicit beliefs and those of the partner he is interacting with. This disjunction may compel him, if he is to continue his proposed action, to bring to sharp awareness parts of his world which were upon the periphery of his consciousness, and to construct for himself understanding which did not previously exist.

Most research studies investigating peer interaction have intentionally paired together subjects with different viewpoints. While differing explanations have been offered by researchers to explain any observed changes in individual performance it is clear that conflict is a potential element in all these situations. However, it remains unclear whether cognitive conflict arising from a socially encountered disagreement is a necessary or sufficient condition for individual progress. It was evident from the previous investigation that social interaction did not evoke progress in every individual. In these instances it is not clear whether these individuals did not experience any conflict or whether other necessary conditions for progress were not fulfilled. Furthermore both Perret-Clermont (1980) and myself have argued the need for an individual to have at least minimal competence before a conflicting viewpoint may provoke cognitive change. Russell (1979) attempted to look for evidence of verbal conflict in a conservation of length task, in which he found little progress for non-conserver dyads. He concluded that the :

> "verbal conflict data suggest that cognitive conflict did tend to take place on a behaviour level between NC's and NC's (non-conservers). Therefore, to some extent it must have been taking place cognitively. This reinforces the view that cognitive conflict does not lead to cognitive change". (p.17).

However, while this clearly implies that cognitive conflict is not a sufficient condition in itself for cognitive change, it may still be a necessary precursor of such change but be ineffective in the absence of other conditions. The preceding analysis has

suggested two further elements that may have to be fulfilled if conflict arising within an interaction between peers is to facilitate greater understanding. Firstly, it has been suggested that the subjects must have control over the learning situation, which should not be disrupted by a dominant personality. Taking the initiative out of the subject's hands may reduce their learning from an active organizing of knowledge to a mere minicry of the dominant individual. Secondly, and closely related to the first point, the subjects must have the opportunity to elaborate and work out discrepant positions for themselves. Learning of this kind may never progress unless the learners themselves have an opportunity to go back over and work through alternative viewpoints and represent them to themselves. This is not to suggest that a totally unstructured and non-directive social situation will be the optimal one. Every teacher who has used group methods has known occasions where groups wasted time, failed to collaborate, or were frustrated in their attempts to make progress. My contention is that given appropriately supportive contexts most children can be self responsible learners.

The present investigation set out to test several of these proposals. Firstly, it aimed to examine the question of whether exposure to a conflicting viewpoint was sufficient in itself to evoke cognitive change. An 'instruction' condition was devised in which pairs of subjects were directed by the experimenter in relation to the moves they should make in order to solve the 3 disc Tower of Hanoi problem. The method they were directed to adopt was the optimal seven move strategy. This was clearly in conflict with the less advanced approaches that these subjects had previously displayed. Subjects in this condition were obliged to carry out the physical transfer of the discs in accordance with the experimenter's instructions and were not permitted to direct or control the proceedings. Neither were they permitted any opportunity to work on the task independently thus denying them the chance to elaborate any ideas for themselves. As a result subjects in this situation were simply being exposed to a discrepant solution strategy from their own,

which also happened to be the optimal one. The question was whether simply encountering a conflicting viewpoint would be sufficient to evoke improvement in the subject's individual performance. The preceding analysis suggests that this will not be the case. Furthermore, since subjects were presented with the correct solution in this condition the extent of individual progress will also reflect upon the question of whether simply telling or showing a child the answer to a problem is an adequate means of developing an understanding for that problem.

This study further set out to examine the changes in performance resulting from two other interactive conditions in which the subjects themselves governed the learning situation and determined the strategy by which they would tackle the problem. These situations varied according to the extent to which they were structured for the participants by the experimenter. One condition was 'unstructured' in that, apart from being directed to solve the problem, the subjects had no other restraints imposed upon them. The other 'structured' condition was identical to the previously successful 'co-operative' situation in which subjects were obliged to carry out the manipulative element of the task together. The issue under investigation was whether subjects who were totally free to structure their own interactions would necessarily adopt roles condusive to the mutual elaboration of their understanding, or whether the situation had to be manipulated in some way by the experimenter to encourage such an approach.

The hypothesis was that both the structured and unstructured conditions would facilitate improved performance more than the instruction condition. No prior expectations were held regarding the relative benefits that may accrue from the 'structured' and 'unstructured' interaction situations. All the interaction sessions were videotaped in order topermit a closer examination of the exchanges that took place within these different situations.

5.2 EXPERIMENTAL DESIGN

Subjects

80 children attending Hardmore Copse County Primary School took part in the investigation. There were 42 boys and 38 girls aged between 7 years 11 months and 8 years 10 months. The mean age was 8 years 4 months. It was an open plan school which was situated in a "middle class" area of Southampton.

5.3 PROCEDURE

Introductory and pre-test sessions

The individual introductory and pre-test sessions were similar in format to the earlier studies. Once again the Tower of Hanoi was the only problem presented to subjects, who had to complete three trials on both the 2 and 3 disc problems. It is worth mentioning that a video camera was present from the very first meeting, although it was only functional during the training sessions. During the first meeting the children were shown the camera and were permitted to examine it. It was explained that it would film them at a later date and any questions they asked were answered. The camera was naturally an object of great interest to most of the children and they were encouraged, as far as possible, to find out all they wished to know about it. Generally after they had satisfied their curiosity their interest in the camera waned. By the time the camera was operational the children had lost their initial enthusiasm for it and they made only infrequent references to its presence.

A change in design from the previous studies was that the third pre-test trial was altered. Instead of this trial being a repeat of the first trial, demanding the transfer of discs between the two end poles, subjects were now requested to move the discs

from one of the end poles to the centre pole. This resulted in three distinct trials and a more representative selection of the possible transfers that can occur between the three poles of the Tower of Hanoi problem.

Training Sessions

During the training sessions pairs of subjects had to complete eight 3 disc trials all starting at the centre pole and alternating between the two end poles. The sessions were filmed to permit a more detailed analysis of the interactions taking place during attempts to solve these problems. Subjects carried out the problems in one of three conditions to which they were randomly allocated. In all situations subjects worked together in pairs which were again randomly formed. There were 26 subjects trained in both the 'instruction' and the 'structured' interaction conditions and 28 trained in the 'unstructured' situation.

The format of the session for subjects trained in the 'structured' situation was identical to that described for the co-operative situation in the previous experiment. In this condition subjects were obliged to co-ordinate the manipulative element of the task by jointly picking up and transfering the discs by means of the attached handles. Thus this situation had been partly defined, or structured, for these subjects by the experimenter in that they were obliged to adopt certain co-operative roles and practices. Similar constraints were imposed on subjects in the instruction situation. However, the restraints on subjects in this situation went further in that they were not permitted to determine for themselves the actual movements of the discs. Thus the method adopted to solve the problem was externally determined and outside of their control. The subjects were instructed to follow the directions of the experimenter who was seated to the side of them. They were informed that he was going to tell them how to solve the problem in the best possible way. The experimenter then directed the subjects through eight correct seven move trials with the subjects jointly moving the discs

in accordance with the instructions. The subjects were permitted to talk and ask questions during the trials but in no instance did the experimenter offer any explanations or justifications to support or explain the strategy being used.

Children who were allocated to the unstructured condition were totally free to manage how they would tackle the problem. Apart from being asked to solve each trial in as few moves as possible no other restraints were imposed upon these subjects. The experimenter informed the subjects of the target pole after which they were left to their own devices to work out the roles that each would adopt and the strategy to be used. This condition was regarded as unstructured since as few constraints as possible were placed upon the subjects in relation to the manner in which they should approach the problem.

Post-test

All post-test trials were carried out individually with each subject being required to complete six trials with the 3 disc problem. The first three trials were a repeat of those carried out at pre-test. The following trials were made up of the only three remaining possible transfers that can be carried out between the three poles of the Tower of Hanoi. After all six trials were completed a fourth disc was added. Subjects were required to complete three trials, with this more complex problem, which corresponded with the first three trials carried out with the 3-disc problem. It was therefore possible to examine the extent to which subjects were able to generalize their understanding of the 3 disc problem to a more complex version of the same task. The optimal solution to the 4-disc problem comprising a combination of two 3 -disc problems separated by the move of the largest disc.

5.4 RESULTS

Figure 5.1 shows the distributions of the number of instances that any particular move sequence was utilized during the training

sessions of subjects in the structured and unstructured conditions. It is important when viewing any of the distributions related to the unstructured group to allow for the fact that there were two more subjects in this condition than in either of the other training conditions. Even allowing for this it is evident that seven, nine and eleven move strategies occured in almost identical numbers in both training situations. The eleven move strategy was not always clearly defined by subjects in the structured situation who frequently made errors in its execution thereby requiring twelve moves to complete this solution. However, the major difference in the performance of these groups is reflected in their use of the thirteen move strategy. The unstructured situation produced substantially greater use of this approach than the structured situation.

Figure 5.3 shows a comparison of the frequency distributions, at pre- and post-test, for the performance of subjects in the structured condition on the 3-disc trials used in both these sessions. The post-test distribution reflects far clearer peaks and the use of particular strategies which were not evident at pre-test. The post-test distribution further indicates the general use of the seven and nine move strategies. There were also a few examples of the thirteen move strategy being used but few other solutions were observed, and there were virtually no examples of non-strategic solutions. The general performance, at post-test, by subjects in the unstructured condition again reflected more organised performances than at pre-test. However, the relative frequencies of the strategies adopted in this condition were quite different from those occurring in the structured condition, (see Figure 5.4). There was evidence of all four strategies with the optimal seven move solution being adopted with similar frequenty to that observed for the structured group. However, the major difference between the two conditions is clearly the prodigious increases in the frequency of occurrence of the thirteen move strategy by subjects in this condition. Once again there were few examples of non-strategic solutions at post-test.

Figure 5.2 shows the same distributions for subjects trained in the instruction situation. Overall, what is clear is that

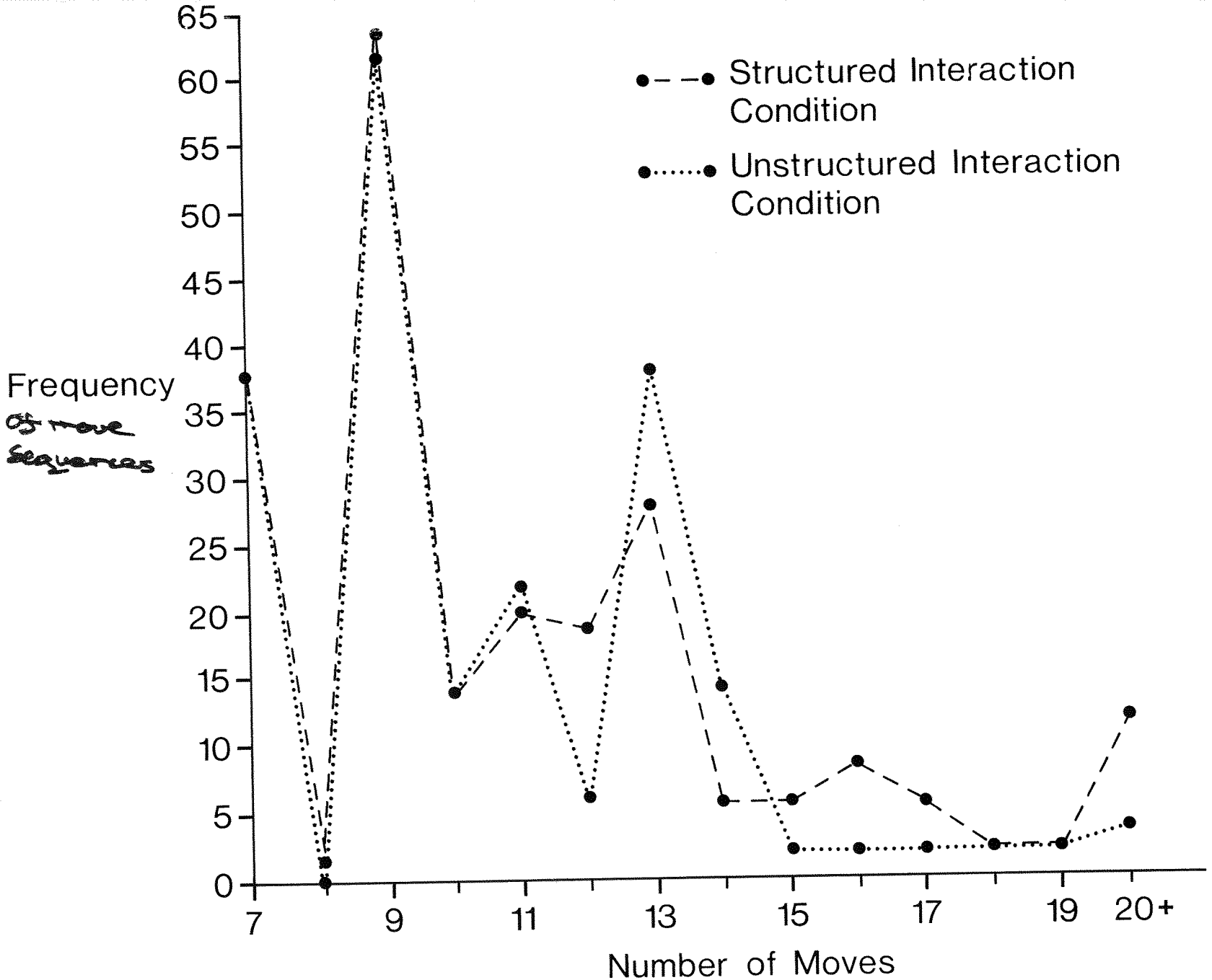

Figure 5.1 The Distributions of Scores Obtained During the Training Trials

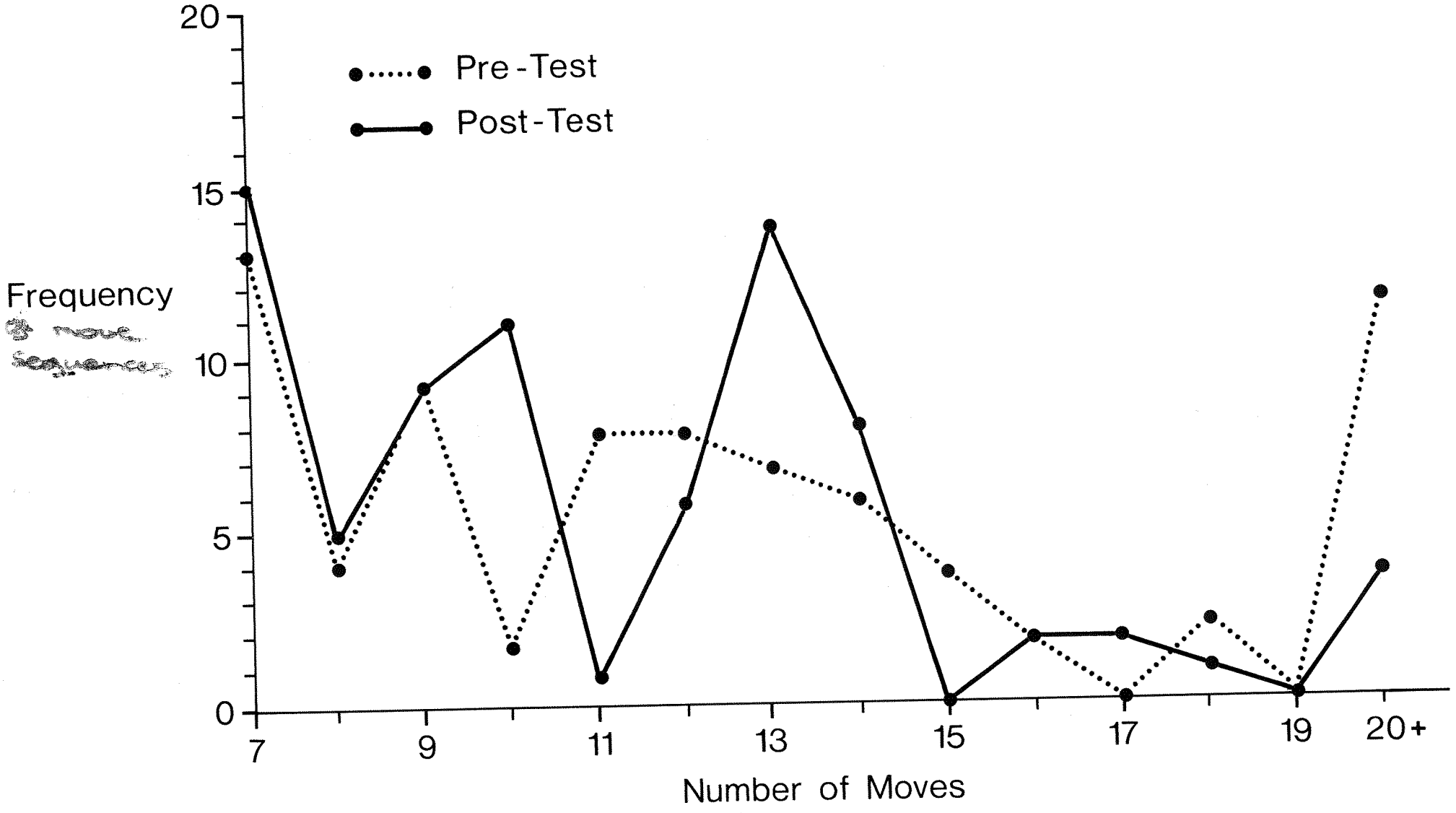

Figure 5.2 A Comparison of Pre and Post-Test Score Distributions for the 3 Disc Trials Carried Out in Both These Sessions
a) Instruction Condition

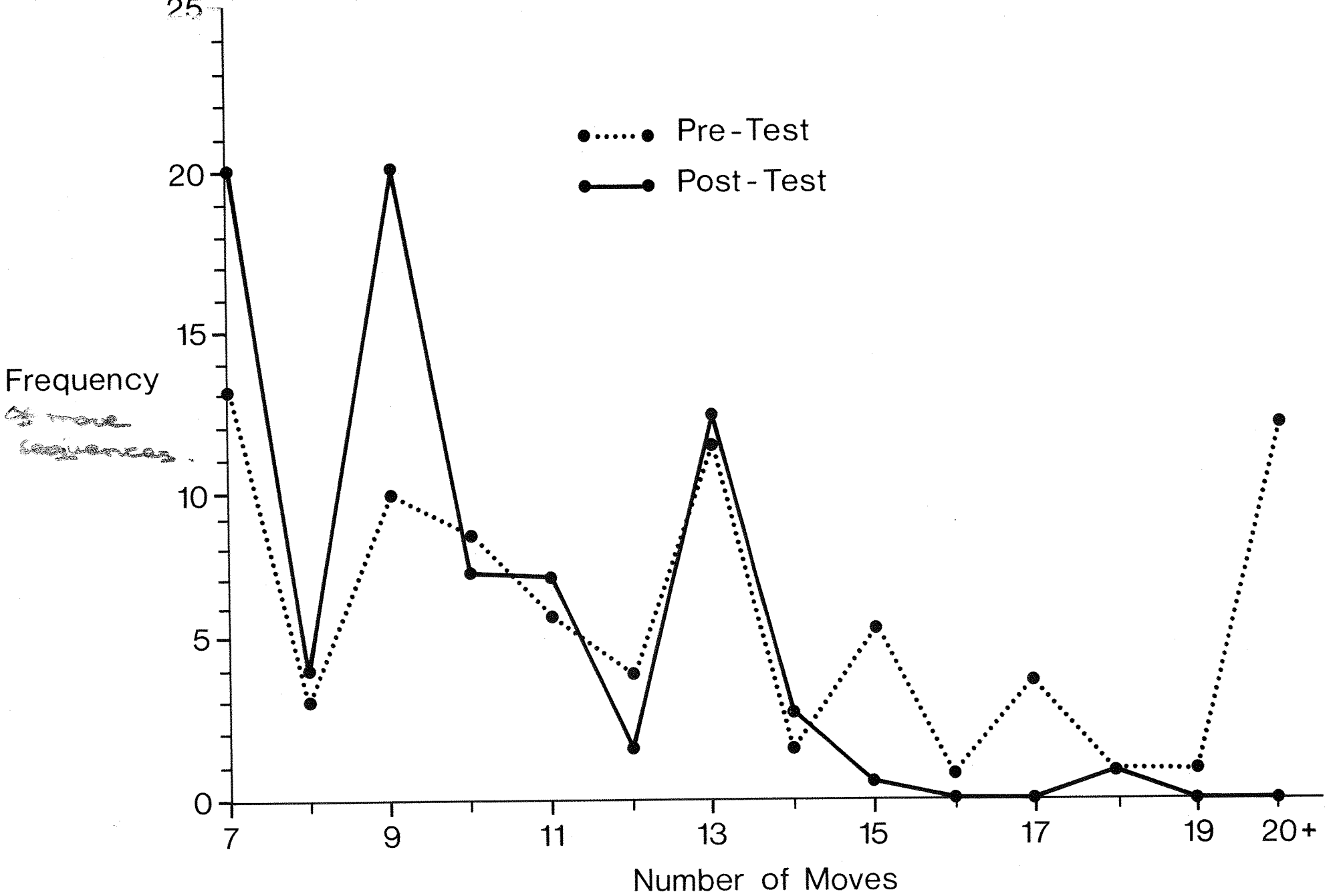

Figure 5.3 A Comparison of Pre and Post-Test Score Distribution for the 3 Disc Trials Carried Out in Both These Sessions
b) Structured Interaction Condition

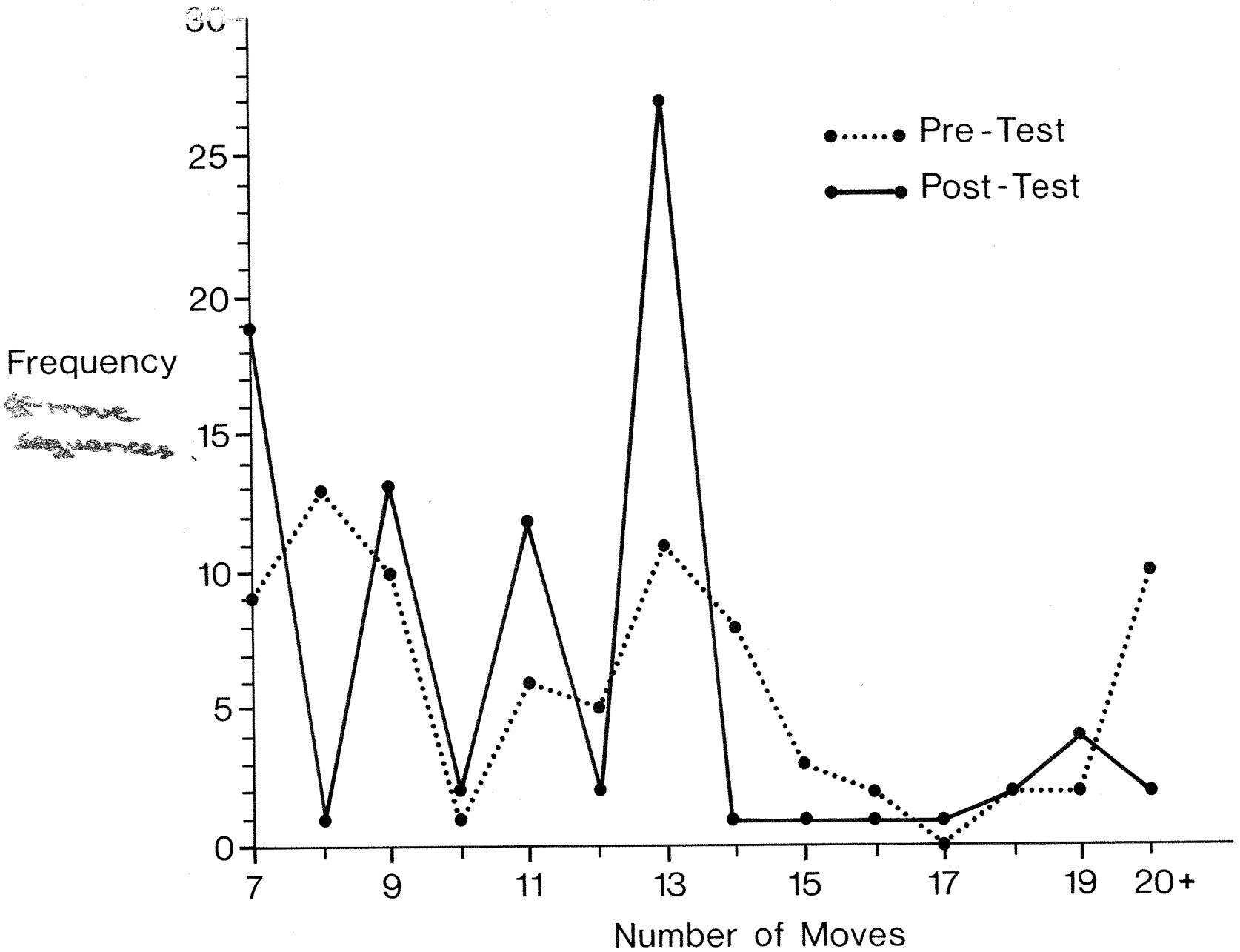

Figure 5.4 A Comparison of Pre and Post-Test Score Distributions for the 3 Disc Trials Carried Out in Both These Sessions
c) Unstructured Interaction Condition

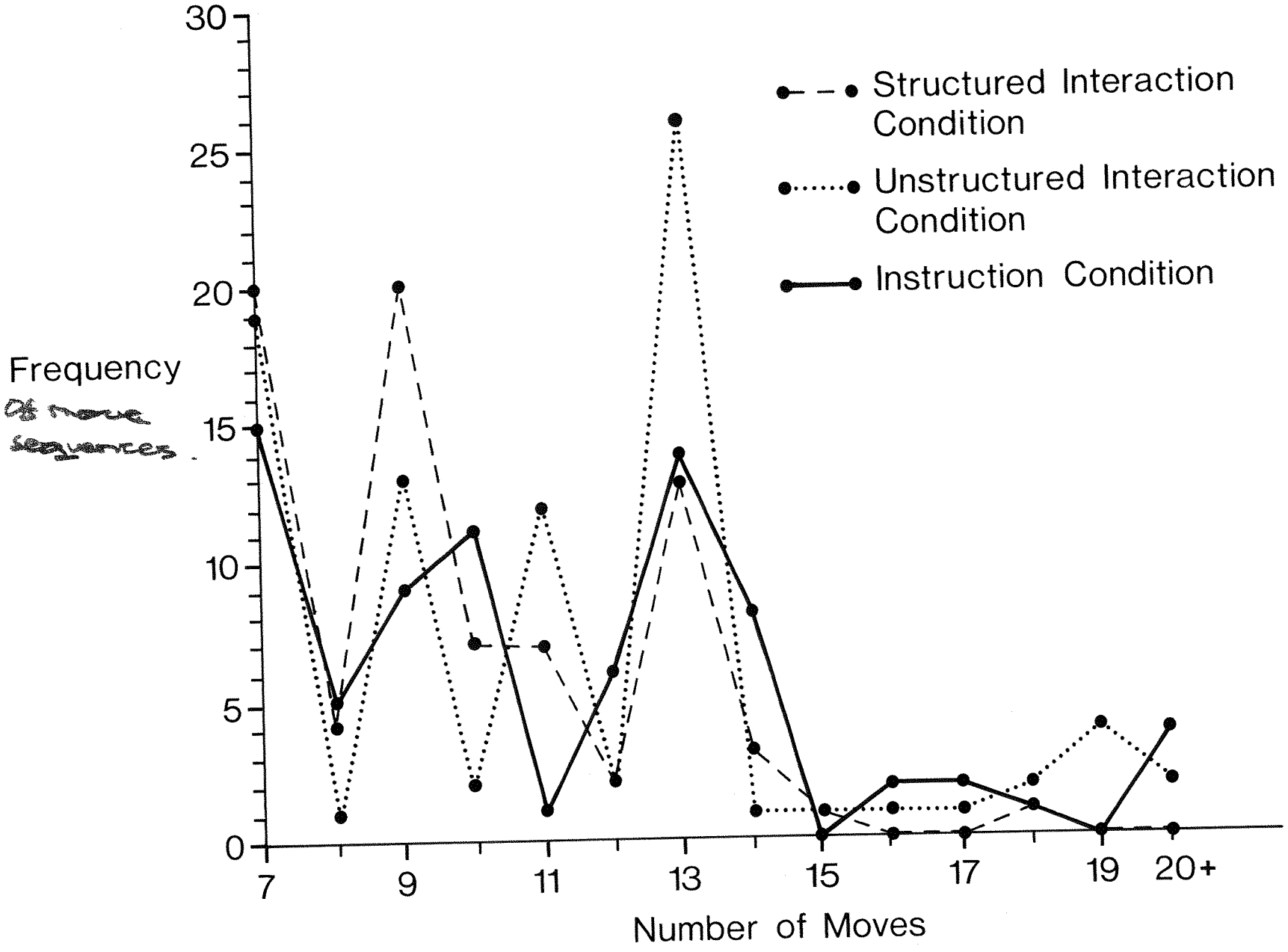

Figure 5.5 Post-Test Score Distributions for the 3 Disc Trials Carried Out at Both Pre and Post-Test

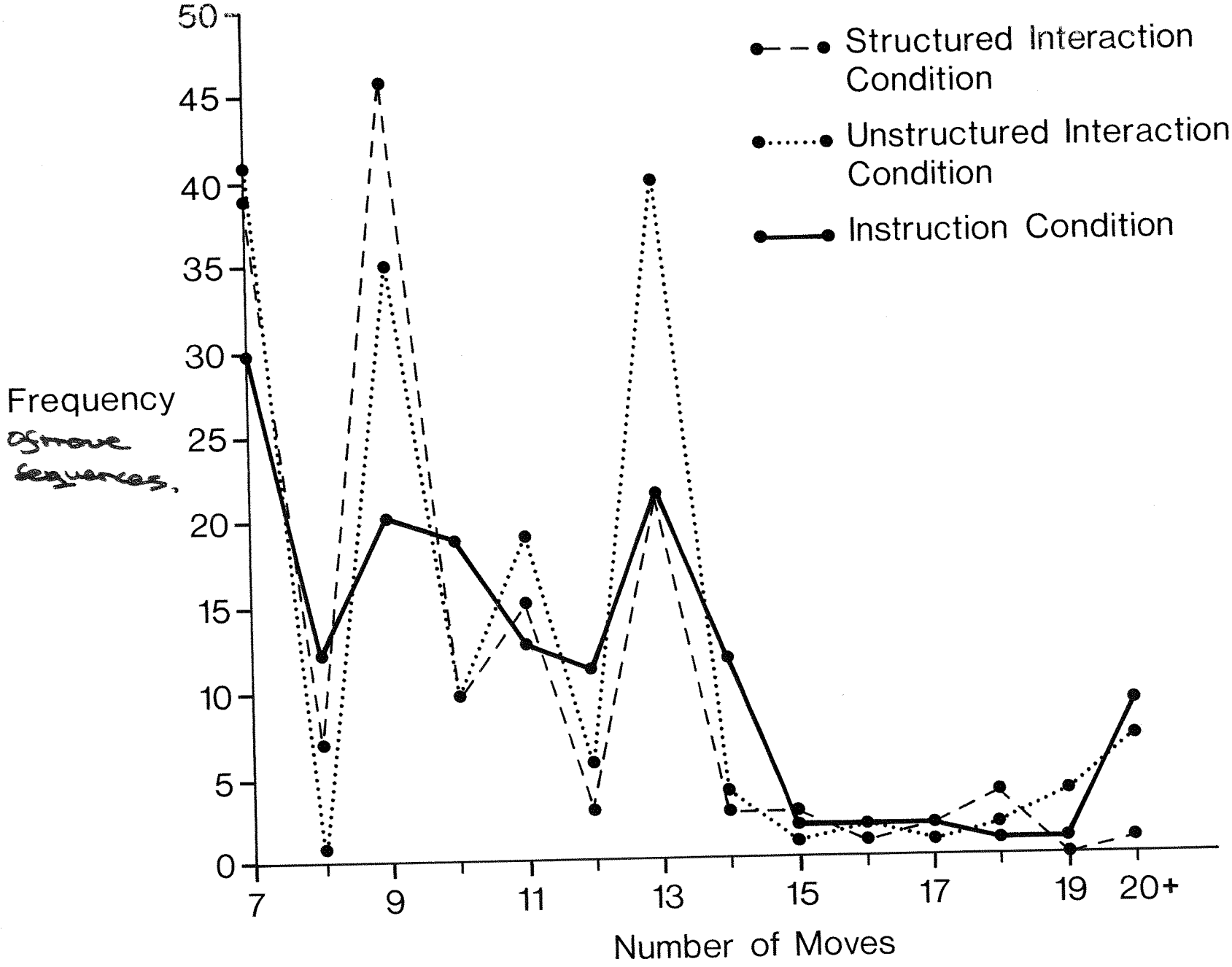

Figure 5.6 Post-Test Score Distributions for All Six 3 Disc Trials

this group did not reflect such a clear change to the use of well-defined strategies at post-test. The major changes from pre- to post-test were a reduction in non-strategic solutions and an increase in the use of the thirteen move strategy. However, other changes were small and not well defined with their being considerable evidence of eight, ten, twelve and fourteen move solutions. This is clearly reflected when the post-test performance of the instruction group on these trials is compared with that of the other two training conditions (Figure 5.5). The instruction group produced a far flatter distribution than the distinctly peaked ones resulting from the other training conditions. Figure 5.6 shows that these differences are maintained when one considers the performance by subjects on all six 3 disc trials used at post-test.

Tables 5.1 and 5.2 show the number of subjects who progressed in each condition whether assessed by the mean number of moves required to solve these 3 disc trials common to both pre- and post-test, or by strategy change. Irrespective of the assessment measure adopted a greater percentage of subjects trained in the structured condition progressed than in either of the other conditions, both of which aided progress in a similar percentage of their members. Again there is support for the proposition that the vast majority of less advanced subjects progress irrespective of the training situation they experienced. 92.0% of these subjects progressed in terms of the number of moves they required to solve 3 disc problems at pre- and post-test, while 79.4% of pre-test non-strategists had adopted strategic approaches by post-test. This was not the case with the initially more advanced subjects. 56.4% of these subjects improved in terms of the number of moves they required to solve 3 disc problems between pre- and post-test and only 34.8% of pre-test strategists developed more efficient strategies.

The progress made by subjects in the structured condition was reflected in a significant improvement, from pre- to post-test, in the number of moves they required to solve the 3 disc problems used

Table 5.1

THE PERCENTAGE OF SUBJECTS WHO PROGRESSED FROM PRE TO POST-TEST AS ASSESSED BY THE MEAN NUMBER OF MOVES THEY REQUIRED TO COMPLETE A 3 DISC PROBLEM

Condition / Pre-test Score Range	Instruction +	Instruction -	Structured +	Structured -	Unstructured +	Unstructured -	Overall percentage who progressed in each score range
8-14	10	9	12	5	9	10	56.4%
14+	6	1	9	0	8	1	92.0%
TOTAL	16	10	21	5	17	11	-
% age who progressed	61.5%	38.5%	80.8%	19.2%	60.7%	39.3%	-

where + = progress

\- = failed to progress or regressed

Table 5.2

THE PERCENTAGE OF SUBJECTS WHO PROGRESSED STRATEGICALLY FROM PRE TO POST-TEST ON THE 3 DISC PROBLEM

Condition / Pre-test performance level	Instruction		Structured		Unstructured		Overall percentage who progressed in each score range
	+	-	+	-	+	-	
Strategists	5	12	7	6	4	12	34.8%
Non-strategists	6	3	12	1	9	3	79.4%
TOTAL	11	15	19	7	13	15	-
%age who progressed	42.3%	57.9%	73.1%	26.9%	46.4%	53.6%	-

where + = progress

\- = failed to progress or regressed

in both these sessions ($t = 4.13$; $p < 0.001$). Subjects in the unstructured and instruction conditions failed to show significant change ($t = 1.47$ and 1.71 respectively). A 1 way anova on post-test performance, using this criterion, revealed significant group differences ($F = 3.54$; $p < 0.05$). Inter group comparisons showed that the structured group performed significantly better at post-test than either the unstructured ($t = 2.32$; $p < 0.05$) or instruction group ($t = 2.11$; $p < 0.05$).

Breaking the groups down according to the subjects pre-test level of understanding revealed no group differences for either the initially more advanced ($F = 2.83$) or less advanced subjects ($F = 1.27$).

Adopting strategy change as the performance measure again revealed overall significant group differences ($F = 3.41$; $p < 0.05$). Inter-group comparisons of strategy change found a significant difference between the structured and instruction groups ($t = 2.48$; $p < 0.05$) in favour of the structured group. No significant differences were found in parallel comparisons between the structured and unstructured conditions ($t = 1.55$) nor between the unstructured and interaction conditions ($t = 0.60$). Breaking the analysis down into comparisons only between subjects who were initially strategy users or initially non-strategy users at pre-test revealed no conditions differences ($F = 2.74$ and 1.08 respectively).

A comparison of overall post-test performance on all six 3-disc trials, as assessed by the number of moves required to solve these problems, once again revealed significant conditions effects ($F = 4.42$; $p < 0.05$). Inter-group comparisons showed that the structured group again performed significantly better than the instruction group ($t = 2.41$; $p < 0.05$). Significant group differences were still observed when only considering the post-test performance of the more advanced subjects ($F = 3.61$; $p < 0.05$). Inter group comparisons for these subjects emphasised the superiority of the structured group in relation to both the instruction ($t = 2.72$; $p < 0.05$)

and unstructured conditions ($t = 3.40$; $p < 0.05$). No group differences were found when comparing the overall post-test performance of the less advanced subjects ($F = 1.35$).

A comparison of the number of moves required at post-test to solve only those trials upon which all subjects had been trained indicated no conditions differences ($F = 2.48$). However, a similar comparison on the four post-test trials not used during training did reveal significant differences between the conditions ($F = 3.34$; $p < 0.05$). Again a significantly better group performance was found for subjects trained in the structured situation than their peers trained in the unstructured ($t = 2.10$; $p < 0.05$) or instruction situations ($t = 2.14$; $p < 0.05$). The performance by subjects at post-test on the three 4-disc trials also showed a significant conditions effect ($F = 3.72$; $p < 0.05$). Again inter-group comparisons revealed significant benefits for those subjects trained in the structured condition as compared with subjects in the unstructured ($t = 2.65$; $p < 0.05$) and instruction conditions ($t = 2.34$; $p < 0.05$).

5.5 ANALYSIS OF VIDEO-TAPES

The video recordings of the structured and unstructured interactions were, first of all, transcribed providing a written account of all the verbal exchanges that took place. The contents of these verbal exchanges were generally imprecise with ideas rarely being fully developed. Utterances tended to be short incomplete and accompanied by many supplementary gestures. Generally the extent of the relevant discourse occurring during the exchanges was very limited. The restricted verbal discourse reflected the difficulty children were obviously experiencing in expressing their ideas and opinions concerning how the problem could be solved. It was evident from these observations that the task did not easily lend itself to descriptions or explanations from the children's point of view. In fact the structure of the Tower of Hanoi is dependent upon quite complex mathematical rules which are not readily apparent even to adults. As a result it is not

surprising that these children could not support and justify a proposed course of action with well reasoned verbal arguments. The nature of the task made it obvious that it would be unprofitable to pursue an analysis of these interactions in terms of the verbal content of the exchanges.

Upon further examination, one factor did appear to differentiate the interactions taking place in these two social situations. This was the extent to which decisions were taken individually as opposed to jointly. The number of instances in which moves were decided upon in either of these fashions was, therefore assessed for interactions taking place between subjects in both conditions. A move was deemed not to have been made jointly and as a result attributed to one member of a dyad only if :

(a) A subject moved a disc by himself without any response from his partner or in spite of any criticisms or alternatives offered by his partner.

(b) A subject verbally or non-verbally proposed the next move which was then carried out jointly or by either partner individually.

(c) One subject's viewpoint prevailed after a disagreement in which a consensus was not achieved.

(d) If a dispute in which both partners were holding a disc and pulling it towards different poles was resolved by one subject pulling the disc to his pole.

The tapes were marked according to these criteria by myself and an independent judge. A Kendall's Rank Correlation test for inter-experimenter reliability on these measures produced a correlation coefficient of 0.83. It was found that between 21.0% and 26.6% of all moves occurring during an interaction in a structured situation were determined - by one subject independent of his partner. This figure rose to between 85.0% and 90.0% in

interactions which were unstructured.

Thus in the structured condition about three quarters of all moves were mutually agreed upon. Individually subjects in this condition only determined on average 11.9% of all moves occurring during their training sessions, within the range of 1.6% to 26.9%. Furthermore, if one proposes the relatively arbitrary criterion that a subject is held to have dominated an interaction if he determines at least twice as many moves as his partner, then there were no examples of dominance occurring in these structured situations.

The situation is quite different when one considers the interactions that occurred in the unstructured condition. Unfortunately, the following analysis only considers eleven out of the fourteen unstructured dyads due to faults arising during videotaping resulting in these sessions being inadequately monitored. Within these remaining eleven dyads each individual determined, on average, 45.5% of all the moves that were made, within the extremely wide range of 3.3% to 94.8%. In seven out of the eleven dyads there was strong indications that one partner was dominating the decision making process. In all these instances one subject determined at least twice as many moves as his partner, however, there were four instances in which one individual decided over five times as many moves as his partner. In all seven instances the dominant partner determined between 41.2% and 91.5% more of the moves than his submissive peer. The remaining four unstructured interactions did not reflect the same asymmetry. In these more symmetrical encounters each partner individually accounted for between 31.2% and 50.0% of the total number of moves made.

In both the structured and the more symmetrical unstructured interactions there was evidence that both the relatively more advanced and the relatively less advanced members of the dyads progressed. However, this was not the case in unstructured interactions which were dominated by one member of the dyad. There was no evidence that these situations were facilitative of cognitive change for subjects

who already approached the task in a strategic manner. There was no instance of a subject at this level of understanding, engaged in this kind of exchange, showing any individual improvement in performance, whether they were the dominant or submissive partner. Four of these subjects did not change their level of performance and three actually showed some evidence of regression. Naive subjects in these interactions who entered the encounter without a clear strategy, mostly progressed and showed no evidence of regression. This is in keeping with the general performance of these subjects in all conditions.

The question of which member of a dyad took on the dominant role, in those instances where this occurred, cannot be answered simply in terms of the relative levels of understanding of the partners. In four of the seven instances the dominant partner was the more advanced child, in two instances he was the less advanced partner and in one case both partners were of very similar ability.

DISCUSSION

The hypothesis, suggested prior to the investigation, that social encounters in which the interactants are in control of their own activities would be more facilitative of understanding than those in which they were not, has only been partially substantiated. This was clearly the case when subjects were trained in the structured situation but was not supported in the case of interactions occurring in the less structured situation. Tables 5.1 and 5.2 emphasise the success of the structured condition indicating that a large majority of subjects in this situation showed evidence of progress. Subjects trained in this way were later individually more proficient with the problem than were comparable subjects trained in the other social situations. When considering overall performance on all six 3-disc post-test trials there was once again support for the proposal that this kind of social experience may have particular benefits

for subjects part-way towards an understanding of the problem. Furthermore, subjects trained in the structured social setting showed greater generalized understanding than their peers in other training conditions. Subjects in all conditions performed equally well at post-test on the two trials which they also confronted during training. However, subjects who experienced a structured interaction with their peers were individually more able to solve parallel problems at post-test as well as more complex versions of the same problem, (i.e. the 4 disc problem). This suggests an increased understanding of the underlying logic of the task for these subjects which did not ensue as a result of the unstructured or instruction training conditions.

The actual training experience of the structured and unstructured groups, at first sight, do not appear to be too dissimilar. Figure 5.1 shows that that solutions produced by peers working in these situations were very similar apart from a greater tendency for thirteen move solutions to occur within the instructional setting. However, the resulting individual post-test performances of subjects in these conditions were quite different. In both instances the performance distributions (figures 5.3 and 5.4) reflected the use of clear strategies by subjects. However, individuals overall adopted more efficient strategies after being trained in a structured rather than an unstructured situation. This is reflected in the finding that the structured group as a whole performed significantly better than the unstructured group at post-test in terms of the number of moves they required to solve the problems but not according to their strategy improvement from pre to post-test. It appears that any performance change observed between pre and post-test is not a simple reflection of those solutions encountered during training. The nature of this reorganisation may depend upon more specific features of the social experience and particularly the means by which solutions were formulated, rather than upon the actual solutions themselves. I will return to this issue again later in the discussion.

The percentage of subjects who progressed in the instructions condition was similar to the number who improved their performance in the unstructured condition. However, these subjects did not generally show the same refinement in their strategies at post-test, but showed a high degree of uncertainty in their performance incorporating unnecessary moves (see figure 5.2). However, again there were few examples of solutions entailing sequences of apparently random moves by subjects in this condition at post-test. This was also the case for subjects in the other conditions and reinforces the observation that the majority of naive subjects progress irrespective of the training they experience. This is also reflected in the high percentage of less advanced subjects who showed evidence of progress (see Tables 5.1 and 5.2).

The failure of the instruction condition to induce a significant degree of progress among its subjects has several important implications. Firstly, it was clear that subjects in this situation encountered a discrepant viewpoint from their own. The solution which they followed at the directive of the experimenter was not the one they themselves had originally displayed when faced with the problem. However, the conflict of this situation was evidently not sufficient in itself to evoke a significant degree of individual cognitive change. This finding gives force to the argument that socio-cognitive conflict should not be viewed in isolation from other factors present in the situation and cannot be attributed with sole responsibility for any individual improvement in performance observed as a result of a social experience. It is further evident, from the performance of subjects in this condition, that simply presenting a correct and ready-made solution to a problem is not always a successful means of improving understanding of that problem. This finding seriously brings into question the claims of those authors who have argued that the presence of a correct viewpoint is the most important feature of an interaction for the facilitation of cognitive change. While it may be an important element in some situations I again wish to suggest that it should not be viewed in isolation from other conditions. Two of these other conditions, which were suggested in the introduction as perhaps being

important features of an encounter, for the furthering of understanding, were the need for subjects to have some control over their learning experience and to have the opportunity for the elaboration of new or discrepant information. Given that both of these factors were available to subjects in the structured and unstructured situations it is clearly important to establish the differences between these conditions since only the structured group facilitated significant improvement in individual performance.

Some help in this issue may be derived from a consideration of what occurs after a conflict of opinion arises. Little attention has been given to the question of how conflicts are resolved and it may be that resolution of conflicts is essential for the facilitation of learning and cognitive growth. One element suggests itself as important in the resolution of conflicts for subjects engaged on the Tower of Hanoi problem which, for the large part involves children in the manipulation of materials. For this task it is possible for the child to engage in hypothesis testing and to resolve conflicts of opinion through action. The picture emerges of a child firstly requiring to encounter a discrepant viewpoint, which he recognises as such, and then having sufficient freedom and control over his situation to actively test out different and contradictory hypotheses until he resolves the discrepancy. Clearly such a process may break down at several points. It may be that during an encounter discrepant viewpoints are never expressed. Or that they are expressed but not recognised as being in conflict and requiring co-ordination. Subjects may encounter and recognise a conflicting viewpoint but may never be afforded the opportunity to come to terms with these discrepant positions and thus to resolve the issue. Or finally subjects, while having the opportunity to resolve perceived differences of opinion may fail to do so.

Within this framework there appears at first sight, little reason to predict a greater facilitation of cognitive growth as a result of a structured as opposed to an unstructured encounter. However, the opportunity for the elements of this process to occur

may be determined by the nature of the interactions occurring in these situations which proved to be quite different. The large majority of decisions taken in the unstructured situation were taken individually, while this made up only a small proportion of the decisions made during structured interactions which were generally mutually agreed by both partners. The nature of the decision making processes in these situations frequently resulted in quite different kinds of social exchanges. The structured situation was characterised by a mutually collaborative approach by the subjects. In contrast many interactions between subjects in unstructured situations were characterised by the asymmetry of the decision making process and the resulting dominance of one member of the dyad.

The issue of which member of the dyad took the dominant role, in those instances where this occurred, cannot be simply accounted for in terms of the partner with the greater understanding of the problem who may have been expected to have a stronger belief in his more justifiable position. It was found that the dominant partner was not always the more advanced child. Russell (1982) has proposed an explanation for instances of this kind. He suggested that in situations where neither partner possessed fully operational understanding of a problem that their understanding was 'pragmatic' and 'subjective'. The individual whose answer will predominate will be determined by individual factors, such as which child is more determined to get his own way, rather than by who possesses the greater understanding. This emphasises the importance of individual characteristics as an important element particularly in relation to the roles that individuals adopt within an interaction. These characteristics clearly interact with the restraints imposed on the situation by the experimenter, in that the structured situation resulted in co-operative behaviours and produced no interactions which were clearly dominated by one member of the dyad.

How may one interpret the kinds of experience subjects

gained in the one-sided social interactions which were characteristic of the majority of unstructured encounters? The dominant subject may be viewed as acting somewhat akin to an individual working alone. He did not permit nor encourage his partner's participation in the task with the result that his partner rarely expressed a viewpoint, and when he did so it was generally ignored. The dominant partner was thus highly unlikely to either confront or recognise a viewpoint discrepant from his own. Without the element of conflict the only subjects who showed evidence of progress were the initially less advanced subjects who, as we have already seen, progressed irrespective of their training situation. The more advanced dominant subjects were not forced to confront alternative solution strategies and therefore had little reason to restructure their own approaches to the problem. On the other hand it does seem reasonable to suggest that the submissive subjects had ample opportunity to perceive conflicting viewpoints from their partner. For large periods of the training sessions they observed their partner performing the task in ways which, we can generally assume, were alien to their own. However, as in the instruction condition, simply perceiving a conflicting orientation to the problem was not sufficient to invoke improved individual understanding, at least in the case of the more advanced subjects. Having been confronted with a discrepant position from their own, these subjects were permitted little access to the problem by their partners and thus had little opportunity to resolve the perceived conflict. Not being permitted the opportunity to actively test out and elaborate different possible approaches to the problem the subject was unlikely to develop his understanding, perhaps remaining in a state of unresolved conflict.

The high incidence of subjects in the unstructured condition adopting the thirteen move strategy as their preferred mode of solving the problem may again be related to the issue of dominance. There were generally two conditions which preceded the uptake of this strategy. One was where a subject with no clear strategy dominated the exchanges. In this situation the non-strategist

appears only to have been able to make limited progress under his own volition. The other was where an initially more advanced strategist adopted this solution after an interaction with a dominant non-strategist. In this case observing the conflicting but less organised approaches of his partner, without the opportunity to be actively engaged on the problem, may have been confusing resulting in the adoption of the least efficient strategy.

The limitations to individual cognitive growth imposed by dominance were not found in more equitable interactions. There was evidence of progress by subjects of all levels of ability after a structured interaction or a non-dominant unstructured interaction. Subjects in these situations have both the opportunity to encounter viewpoints different from their own and also to jointly explore possible means of resolving these discrepancies. The mutually collaborative roles adopted by subjects appear highly condusive to the elaboration of differing approaches permitting both individuals the opportunity to clarify and elaborate their own positions. There was no evidence to suggest that subjects will individually adopt the same approaches to the problem after this kind of social experience. Clearly subjects start from divergent positions and the conflict they experience will be partly dependent upon their initial perspective, which will be instrumental in formulating any new viewpoint. The co-operative element in these situations suggests itself as an important feature of their success, and mutual collaboration may be a particularly effective means of identifying alternative perspectives on a problem and of developing and elaborating new understandings from these perspectives.

Other authors have supported the proposal that dominance can disrupt individual progress. Doise (1978) found, also using a task involving manipulation of materials, that pairings between children with very low and very high pretest scores resulted in little progress, a fact that was attributed to the domination of the

interaction by the more able child. Clearly a common feature of this study and the present investigation is that the tasks used are similar in that they are both primarily manipulative. It has been found, at least in relation to the Tower of Hanoi problem, that the amount of task related verbal discourse was very limited in all situations.

However, verbal discourse may play a far more important role when the focus of attention of the interaction is a task for which verbal explanations and judgements are readily available. As numerous studies have testified, interactions concerned with problems of conservation where the dominant child is fully operational and able to provide verbal explanations of his judgements may indeed be beneficial for his submissive non-conserving partner. Thus perceiving a conflicting view which is supported by verbal justifications and explanations may enable the non-conserver to resolve the conflict. This suggests a second means by which socially perceived conflict may be resolved. Indeed Doise, Mugny and Perret-Clermont (1975) found that the cases where conservers consistently gave reasons to support their position were those most likely to result in gains by the nonconserver. This further suggests that the means of resolution of conflict may be task dependent and that social dominance may have a different meaning and different consequences according to the task involved.

The results of the study by Russell (1979), referred to in the introduction may be interpretable in these terms. Using a conservation of length task he found significantly greater progress for nonconserving subjects paired with a conserver than for those paired with another nonconserver. Examination of the verbal exchanges showed that conflict did occur in the nonconserver pairs, leading Russell to argue that cognitive conflict is not sufficient to ensure cognitive progress and that exposure to the correct answer is also needed. However, from the point of view of resolution of conflicts, it may be important that little or no manipulation of materials

seems to have occurred. Conflicts were thus likely to be resolved only through clear verbal reasoning, something more likely to be found in the presence of a conserver. Had the task involved more active manipulation of materials and a chance to actively test out the conflicting viewpoints, the findings might have been different. The medium of verbal exchange as a means of expressing and resolving conflicting viewpoints will be more closely examined in the following chapter.

To conclude a more complex picture is developing of the components of an interaction which are influential in determining the extent of any benefits that it may produce. It has been proposed that the individual characteristics of the interactants, the structure imposed on the situation by the experimenter and the nature of the task will all combine to determine the roles adopted by the participants and the kinds of exchanges observed. Mutually collaborative interactions have been found to be particularly facilitative of cognitive progress. It has been found that conflict arising during an encounter is not sufficient by itself to evoke improved individual understanding, and it has been suggested that subjects must have the opportunity to resolve that conflict via active manipulation of materials and hypothesis testing or via verbal reasoning. For this to occur it has further been proposed that subjects must have control over their encounter situation and the opportunity to elaborate and develop opposing viewpoints. In the following chapter I will consider in more detail the role verbal exchanges may play in some social learning situations. The apparent task dependence of a detailed analysis of peer interaction will be further investigated and the question of whether social interaction can facilitate understanding across a broad age range will be considered.

CHAPTER 6

AN INVESTIGATION OF THE VERBAL ASPECTS OF INTERACTIONS BETWEEN PEERS AND ITS RELATIONSHIP TO THE PROBLEM UNDER CONSIDERATION

6.1 THE ISSUES TO BE INVESTIGATED

This chapter will consider the question of the role verbal discourse may play in the transmission and resolution of discrepant opinions arising between peers engaged on a task for which appropriate verbal judgements and explanations are possible. In considering the use of language to participate in the shaping of knowledge I am making some assumptions about the kind of knowledge involved. As has been described much learning may occur while children manipulate concrete materials with little recourse to discussion, nor may talking necessarily contribute to 'recipe' learning, without much care for underlying principles. However, for appropriately verbally oriented tasks, for which children attempt to group underlying principles and to use the new knowledge as a means of recoding former experiences, discussion may be of central importance.

The idea of language as a tool for making meaning as well as for communicating existing meanings was very clearly present in the writings of the anthropologist Edward Sapir (1949), who commented that :

> "Once the form of a language is established it can discover meanings for its speakers which are not simply traceable to the given quality of experience itself but must be explained to a large extent as the projection of potential meanings into the raw material of experience" (p.123).

Sapir is here crediting the power of generating new meanings not to the language as a whole but to speech. A similar view has been held by more than one school of psychologists.

Vygotsky (1962) in "Thought and Language" presents speech as a means of guiding action and interpreting the world. He argued that speech for oneself originates through differentiation from speech for others and that it does not merely accompany the child's

activity but serves mental orientation, conscious understanding and it helps in overcoming difficulties. Bruner (1966) has also consistently urged the importance of language in cognitive development. He extends this importance to the act of speaking when he describes language as : "not only the medium of exchange but the instrument the learner can use himself in bringing order into the environment" (p. 204)

There is an important difference between arguing that the development of cognition depends on the developmentn of language - an assertion which Piaget has firmly rejected - and arguing that speech enables us to control thought. It is the second of these that Sapir, Vygotsky and Bruner hold in common. They all see language both as a means by which we learn to take part in the life of the communities we belong to, and a means by which we can actively interpret the world about us, including that life itself. Through language we both receive a meaningful world from others, and at the same time make meanings by reinterpreting that world to our own ends.

Psychologists who have investigated the relationship between speech and cognitive processes have tended to choose mental activities very unlike those with which I am concerned here. Furthermore they have generally shown little interest in an analysis of verbal discourse in order to discover which factors may facilitate cognitive change. There is a multitude of published studies relating to the effect of naming or describing upon perception, discrimination, recognition or memory, but these are only marginally relevant to the matter in hand. There are however a few studies which approach directly the effect of speech upon problem-solving.

Gagne and Smith (1962) set adolescent boys the Tower of Hanoi problem. Half the subjects were asked to explain as they made a move why they were doing it, and these were found to be significantly more successful in solving the problems. It seems that explaining the purpose of their moves helped the subjects to re-interpret the

data in the light of the problem. In another study Marks (1951) gave adults the task of finding out where in the course of a computation a group of errors had occurred. There were four possible sources of error to be investigated. In the part of the experiment which concerns us here, Marks placed in front of some of his subjects a written list of possible sources of error but this had no effect upon their success. However, he interrupted some subjects at intervals in order to ask them to put into words the ways in which the errors could have occurred. This group proved very much more likely to reach a correct solution than those who were presented with a written list, or those who received neither the list nor the demands to verbalize one for themselves. It is worth noticing that this part of the experiment included not only verbalizing but also a face-to-face relationship in which the experimenter's questions played an important part, since they required the learner to represent to himself what he already knew. It was necessary for the subjects themselves to talk about possibilities ; someone else's list did not help them to solve the problem. The results of these studies contrast markedly with studies in which the experimenter presents subjects with verbal principles and instructions. This situation has not been found to facilitate improved performance for a variety of logical problems (e.g. Katona, 1940 ; Haslerud and Meyers, 1958 ; and Corman, 1957). Taken together, these studies suggest that learners will achieve more insight into underlying principles (i) if they themselves rehearse aloud the demands of the task which they are facing ; (ii) if they put into words what they are doing with the data, and with what purpose ; and (iii) if they do so repeatedly in response to questions from someone else. They emphasise the importance of the subjects being actively involved with the task and the value of verbally representing attempts to solve a problem. During interactions between peers subjects may not only clarify their own views in this way but by doing so may provoke a conflict between differing viewpoints. There is support for the proposal that this conflict may be resolved most effectively when subjects produce consistent and coherent arguments and explanations to defend their position (Doise, Mugny and Perret-Clermont, 1975). Unfortunately no attempt has been made to provide a detailed analysis of the verbal exchanges occurring between subjects

in these situations which may indicate some important factors initiating cognitive change. One aim of the present investigation was to select a task which would stimulate verbal interaction, to videotape social interactions occurring with this task and to analyse the content of the verbal discourse. Specifically I was interested in whether any support would be found for the existence of socio cognitive conflict during interactions. The previous investigations using the Tower of Hanoi problem have only been able to indirectly infer its existence due to the non-verbal nature of this task.

The selection of an appropriate task to fulfill these requirements deserves some comment. Many of the reasoning problems which a child encounters differ from those previously adopted for research purposes in that they will not be well formed. A problem is well formed if (like an arithmetical calculation) it is open to a single solution, the validity of which can be demonstrated. Tasks which are not so well-formed compel the individuals to decide on what principles the data will be selected and ordered, whereas in a well-formed problem this is already decided. In effect the child has to formulate problems as well as offer solutions. Speech is likely to have a particularly important part to play in learning of this kind.

The task chosen ('Logic 5') was a commercially available microchip version of the peg game 'Mastermind' (see figure 6.1). Children had to identify a three digit sequence selected at random by the device, which gave feedback in respect of the children's entries. The device randomly selects a three digit sequence. In the numbers that it generates no digits are repeated. Each time a guess is entered it is compared with the numbers held in the device's memory. Feedback is given to the subject relating the number of digits he entered which correspond with those in the memory and also how many of the correctly guessed digits are in their correct position in terms of the sequence of digits comprising the number. No information is given to enable subjects to directly identify which digits are correct and/or are in their correct sequence. It is possible via deduction to eliminate

Figure 6.1 The Logic 5 Game

some digits as not being in the number held in Logic 5's memory and to confirm others, thus eventually establishing the correct identity of the 3 digit sequence. The task is thus semi-structured in that it has a single solution, but there is no clearcut ideal strategy for obtaining this solution. After each entry the subject will have several possible options available for his continued performance some of which will be more risky than others. At each such juncture he will have to reassess the problem in accordance with the feedback just obtained along with that obtained from his earlier entries. According to his assessment of the information available the astute subject will select one of several possible courses of action which may prove to be the most profitable. Pilot work carried out with this task revealed that 7-8 year old children, working in pairs, were constantly engaged in verbal discourse. It was therefore decided that this was a suitable task environment in which to monitor verbal exchanges between peers and also to assess the relationship between this discourse and later individual performance on the problem.

This investigation further aimed to clarify the proposed distinction between what I have called verbally oriented and non-verbally oriented tasks. Logic 5, it is suggested, is more akin to the former while the Tower of Hanoi is more suitably described in the latter category. It was decided that each dyad of children would perform on both tasks and that a qualitative and quantitative analysis of the verbal exchanges that occurred with each task would be undertaken and these would be compared.

A further issue to be considered in this investigation relates to the question of the age of the subjects. Experimental studies of peer interaction have almost invariably employed Piagetian concrete operational tasks. One consequence of this is that they are all directed at the same age range of subjects (approximately 7-9 years). All evidence of positive transfer from peer interaction to individual performance thus relates to a specific age range. While adult social psychological studies have given much attention to group performance, very few studies have examined individual

sequalae of group experience, and no evidence of positive transfer has been obtained (e.g. Laughlin and Sweeney, 1977). It is thus possible that the efficacy of peer interaction in stimulating individual learning is a phenomenon restricted to early childhood. Such a view can indeed be supported by reference to the theoretical writings of Mead or Vygotsky, both of whom emphasised the sense in which development proceeds from intermental to intramental. Mead (1934) argued that the development of self awareness in the child was achieved first of all with respect to particular other individuals. The child's final images of himself are gained in close interaction with one or two particular social others from which he becomes aware that others have thoughts, feelings and points of view which may differ from his own. In time, the standpoint from which the child views himself becomes relatively generalized and the child constructs an internal 'generalized other', so that his self awareness is no longer tied to actual interactions with particular others. Exterior discourse with a 'particular other' (another person) may be vital for the young child to obtain an insight into his own behaviour, whereas the older child or adult can in effect conduct an interior discourse with a 'generalized other'. Also Vygotsky (1962) argued for the existence of an 'inner speech' which for adults is the silent equivalent of children's egocentric speech. Such inner speech would be the most accessible part of thought, thus making our thinking and feelings open to introspection and control. Mead argued that reflective thinking essentially consists of internalized dialogue. The child comes to be able to signify meanings to himself, and is thereby enable d to direct, control and organise his own behaviour. The achievement of reflective thought is held to mark the achievement of intellectual autonomy, since the individual can now monitor and modify his own behaviour without the necessity for interaction with others.

However, it may be that interaction will be facilitative of learning for all ages, including adults, provided that the task lends itself to structured interaction and is presented at a level of difficulty which is challenging to those involved. This latter point is clearly

important since if the task is so straightforward that all adopt a similar strategy, interaction cannot be expected to have much effect. The evidence presented in this thesis, to date, has suggested that social interaction will be particularly facilitative of understanding for those subjects who have at least a partial understanding of the problem under investigation, as opposed to naive individuals. In order to examine the issue of age it was decided to extend the age range of subjects and further to examine whether the nature of exchanges are qualitatively different for different ages. There were, however, two restraining factors on the age range of subjects used in this investigation. Firstly, since it was decided to compare the content of interactions, for subjects of different ages, it was essential that all the subjects were drawn from a similar population. This could best be achieved by drawing upon pupils from only one school thus at least ensuring that subjects all lived in the same catchment area. The age range of the pupils at the selected school, and thus also of this investigation, was 5 to 13 years. To have extended the age range further would have produced another problem. In order to examine the qualitative aspects of interactions of the different age groups it was essential that subjects should be engaged on identical tasks. Clearly the difficulty of the tasks limited the viable age range of the subjects. The two tasks selected were the 3 disc Tower of Hanoi problem and the 3 digit Logic 5 problem. Initially it was proposed to present children from three age groups (i.e. 5 to 6 year olds, 7 to 8 year olds and 12 to 13 year olds) whith both of these problems. Unfortunately the 3 digit problem of the Logic 5 task proved to be too difficult for 5 to 6 year old children and thus only the two older age groups attempted this task.

To summarise ; there were three aims of this investigation. Firstly, to examine how the make-up of two quite different tasks may influence the kinds of exchanges that occur during an interaction. Secondly, it attempted to monitor and closely examine the verbal exchanges that occurred during these interactions with particular interest in looking for evidence of conflict and how, or if, this conflict is resolved. Finally, the investigation attempted to approach

the question of whether peer interaction is facilitative of individual learning over a wider age range than had previously been demonstrated.

6.2 EXPERIMENTAL DESIGN

Subjects

91 children acted as subjects ; 27 aged between five and six years (mean 5 years, 8 months, range 5 years 2 months, to 6 years 5 months) 30 aged between seven and eight years (mean 7 years 5 months, range 7 years 0 months to 8 years 2 months), and 34 aged between twelve and thirteen years (mean 12 years 10 months, range 12 years 7 months to 13 years 7 months). All the children were pupils at Bevois Town First and Middle School which is situated in one of the poorer areas of Southampton. Many of the children came from multi racial backgrounds. In some 30% of cases, evenly distributed across the age groups, the child derived from a family in which there was at least one non-English speaking parent.

6.3 PROCEDURE

Once again the research paradigm entailed an individual pre-test, followed by either a paired or individual training session and an individual post-test. Prior to the pre-test session the experimenter spent time in the classrooms and was involved in several of the children's activities in order to help make the initial contact. This was followed by introductory meetings between the experimenter and each individual subject which fostered their relationship and presented the opportunity for the experimenter to introduce each child to the forthcoming experimental sessions. These meetings along with all the following sessions took place in a small study room at the back of the school's library.

Pre-test

During the pre-test each child was individually introduced to both the Tower of Hanoi and Logic 5 tasks. The order of presentation of the tasks was alternated. The introduction of the Tower of Hanoi problem and the method of assessment of each subject's initial performance was carried out in an identical fashion to the pre-testing sessions with this task in the previous investigation.

A measure of the children's initial level of performance on the Logic 5 problem was not made during this session which was simply used to introduce subjects to the problem. This task did not lend itself to good individual pre-testing for two reasons. Firstly, I had to introduce the task, which is quite a complex one, and had to do so in relation to randomly selected three digit sequences. Similarly selected sequences were also subsequently used in the training sessions. It was difficult to introduce the task and to measure initial performance on it at the same time. Secondly, I had no control over the particular digit sequences selected, and since some proved harder than others, at lot of 'noise' was involved. At the design stage of the experiment this did not appear tobe too serious a difficulty since I was particularly concerned with 'between groups' analysis, however, it did provide later problems when considering analysis at an individual level.

Logic 5 was described to children as a new computer game. They were told that the idea of the game was to find a secret number that the machine would choose and keep in its memory. The physical workings of the device were described in detail until the experimenter was satisfied that each child was fully conversant with them. They were informed that the secret number, which they had to try to discover, was in the hundreds and so had three figures in it. It was further explained that the number was always made up of three different figures because Logic 5 would never select a number with two of the same figures in it nor one in which all three figures were

the same. Examples were provided for the subjects. In order to find a target number it was explained that one had to discover two things. Firstly, it was necessary to find out which three figures made up the number. Examples were then given of hypothetical guesses which corresponded to differing degrees with a hypothetical target number. It was further demonstrated that it was possible to have selected the correct three figures but not to have correctly identified the target number due to their order being different. It was emphasised that to get exactly the same number it was essential to have both the correct three figures and the correct order.

Subjects were shown how to enter guesses into the device and consideration was then given to the interpretation of the feedback given. The feedback consisted of an indication of how many figures in the guess were correct and how many of these correct figures were also in their correct position. No information was provided which permitted the subjects to directly establish which figures were correct nor which ones were also in their correct position. Subjects were told that the idea of the game was to find the correct number in as few entries as possible and that it would help if they kept a record of each entry and the associated feedback. They were, therefore, requested to write down each guess and alongside it the related feedback on specially designed record sheets. Thus the procedure subjects followed was firstly to choose a three figure number and write it down on the record sheet. They then entered it into the machine and waited for the feedback. This was then also recorded on the record sheets. This sequence was carried out in a similar fashion for each subsequent entry.

During this session subjects either completed two problems or were permitted up to 20 guesses on each of two problems. If subjects had not completed a problem at this point they were generally approaching the problem in a random fashion and it was decided, due to time limitations, to end their attempts at this stage. In all cases the aim of this phase of the experiment was to ensure that each subject clearly understood the workings of the game. During the

session the experimenter guided the subjects in relation to filling in the record sheets, interpreting feedback when it was misunderstood and answered any questions. No guidance was given to the subjects regarding their selection of entry numbers. At the end of each session the experimenter was satisfied that each subject understood the nature of the task.

TRAINING

The subjects were randomly allocated from each age group to either an individual or a paired training situation. Thirteen subjects aged 5-6 years were allocated to the 'individual' condition along with fourteen 7-8 year olds and sixteen 12-13 year olds. Likewise, fourteen 5-6 year olds, sixteen 7-8 year olds and eighteen 12-13 year olds were trained in pairs. Within each age group subjects in the interaction condition were randomly formed into dyads. During the training sessions subjects in both conditions were again confronted with both tasks. The order of presentation of the tasks was alternated. All the paired interactive training sessions were video-taped.

For the Tower of Hanoi problem the individual training session was identical in format to that described in chapter 4 and the paired condition was identical in form with the 'structured' social situation described in the previous chapter. When presented with the Logic 5 problem subjects in both conditions were informed that they had to complete as many games as possible in 40 entries. After the fortieth entry, irrespective of how far on they were in a game, they were obliged to stop. This limitation ensured that all subjects had similar amounts of exposure to the task. Subjects facing this task individually were given identical instructions to those received during the introductory session. Subjects working in pairs were again informed of the rules of the game but were given two additional instructions. Firstly, it was emphasised that they should work together and that they were to jointly formulate and agree upon each entry. Secondly, they were both given record sheets and informed that after jointly deciding upon an entry they must <u>both</u> record it on their own

separate sheets. They were directed to take turns at putting the entries into the machine but both were required to record the feedback from each entry on their individual record sheets. They were thus to work together but keep separate, although identical, records of their performance. Such a situation, it was thought, would create a fairly structured co-operative environment for the subjects to work in.

POST-TEST

All post-test sessions were carried out individually. These sessions once again incorporated both tasks and their order of presentation was again randomized. The format of this session for the Tower of Hanoi problem was identical to the post-test described in the previous chapter with the exception that no 4-disc trials were presented.

During this session subjects were also required to complete four games of the Logic 5 problem. Their performance was assessed according to the number of entries they required to correctly complete each problem. Due to the limited time available subjects were restricted to twenty entries per game. Those who failed to complete a game before this juncture were requested to start a new game. Subjects who required more than twenty moves to find a solution to a problem appeared not to be utilizing any clearly defined strategy and it was a matter of chance as to how many more entries would have been required for the task to be completed.

6.4 RESULTS

The Tower of Hanoi Problem

Table 6.1 shows that the 5-6 year old subjects initially had the greatest scope for improvement and indeed showed the largest amount of progress between pre and post-test in terms of the number of moves they required on average to solve a 3-disc problem. It is

Table 6.1 THE MEAN NUMBER OF MOVES SUBJECTS REQUIRED TO SOLVE THE THREE TOWER OF HANOI TRIALS ENCOUNTERED AT BOTH PRE AND POST-TEST

Age	Condition	Pre-Test (Mean no. of moves)	Post-Test (Mean no. of moves)	Improvement (No. of moves)
5/6 yrs	Paired	15.3	9.8	5.5
	Individual	14.9	11.6	3.3
7/8 yrs	Paired	13.0	9.8	3.2
	Individual	12.7	11.1	1.6
12/13 yrs	Paired	10.7	8.6	2.1
	Individual	11.0	8.7	2.3

Table 6.2 THE PERCENTAGE OF SUBJECTS UTILIZING THE OPTIMAL SEVEN MOVE STRATEGY, AN INTERMEDIATE STRATEGY OR NO STRATEGY FOR THE SIX POST-TEST TOWER OF HANOI TRIALS

Age	Condition	Non-strategist (on at least 1 trial	Intermediate or mixed strategist	Optimal strategist (on all 6 trials)
5/6yrs	Paired	7.1%	78.6%	14.3%
	Individual	61.5%	23.1%	15.4%
7/8yrs	Paired	12.5%	62.5%	25.0%
	Individual	7.1%	92.9%	0.0%
12/13yrs	Paired	0.0%	44.4%	55.6%
	Individual	0.0%	43.7%	56.3%

further evident that the post-test performances of the 5-6 year olds and the 7-8 year olds were very similar when assessed according to this criterion. Subjects from both age groups who were trained under the same conditions required a similar number of moves to solve the post-test problems. There were, however, condition differences. Children trained in pairs, from both age groups, generally required less moves on average than their individual counterparts to solve the same problem. Table 6.1 also indicates that the 12-13 year old subjects were the most advanced at pre-test. The improvement shown by subjects of this age in both conditions was similar, and they were again the most advanced performers on average at post-test.

Table 6.2 reflects the distribution of strategies being used by subjects at post-test. The 5-6 year old and 7-8 year old subjects trained in the social situation again reflect similar post test performances. In both instances the majority of these subjects adopted intermediary or mixed strategies, although a greater percentage of the 7-8 year olds had successfully made the transition to the optimal strategy. The subjects of these same age groups trained individually who had required on average a similar number of moves to complete the post-test trials, however, reflected different distributions in relation to the strategies they adopted. Nearly all the 7-8 year olds trained individually utilized intermediate or mixed strategies at post-test. The majority of their 5-6 year old counterparts on the other hand still showed intermittent evidence of non-strategic solutions. However, perhaps surprisingly, over 15% of this youngest group had successfully mastered the optimal solution. Table 6.2 also reflects the similarity of performance of 12-13 year old subjects after both training conditions. For both groups there was approximately 56% of subjects who used the optimal strategy. All other subjects adopted intermediate or mixed strategies.

A two way Anova which considered the performance of children on all 6 post-test Tower of Hanoi trials from each of the age groups in the two training conditions revealed significant effects for

the two main variables. The age of the subjects was a highly significant determinant of performance ($F = 9.85$; $p < 0.01$) with the older subjects performing better than their younger peers. The training condition of the subjects also had a significant influence on the subject's performance ($F = 4.43$; $p < 0.05$), those subjects trained in dyads being more successful than those trained individually. There was no interaction effect between these variables ($F = 0.99$).

A comparison of strategy change between pre and post-test for all subjects irrespective of age, who at pre-test were non-strategists revealed no significant condition effects ($t = 1.49$). All 24 subjects at this level who were trained in the social condition progressed, while 17 out of 21 similar subjects trained individually also progressed. Only 7 out of the 41 subjects who progressed adopted the optimal strategy at post-test. The other 34 used an intermediary or mixed strategy.

An examination of the progress made by all subjects who at pre-test were already using a strategy showed a significant benefit for subjects trained in the paired condition ($t = 2.80$; $p < 0.01$). 20 out of 24 subjects in the paired condition progressed to more efficient strategies as compared with only 4 out of 22 subjects trained individually. Furthermore 5 of the subjects trained individually regressed at post-test to non-strategic approaches to solve the problem.

The Performance of 5-6 year olds on the Tower of Hanoi

A comparison of pre to post-test improvement, as assessed by the number of moves required to complete the three 3-disc problems used during both these sessions, revealed a significant improvement for subjects trained in both conditions (Individuals $t = 3.29$; $p < 0.003$: Paired, $t = 4.56$; $p < 0.0001$). No significant differences were found between the two training conditions whether performance was measured according to the mean number of moves required to solve a group of problems, or by the strategies adopted to achieve these

solutions. Only 6 out of the 27 subjects in this age group approached the 3 disc problem in a strategic manner at pre-test. Of the 21 remaining naive subjects 19 showed evidence of progress at post-test independent of the particular type of training they received.

The Performance of 7-8 year olds on the Tower of Hanoi

Once again subjects in both training conditions showed evidence of progress in relation to the number of moves required to solve the three trials used during pre and post-testing (Individuals : $t = 2.29$; $p < 0.05$; Paired, $t = 5.26$; $p < 0.0001$). Subjects trained in the paired condition, however, performed significantly better on these problems at post-test than their individual counterparts, whether performance was assessed according to the mean number of moves required for their completion ($t = 2.78$; p 0. 05) or by strategy improvement ($t = 2.78$; $p <$ 0. 05). A comparison of the total number of moves subjects in each condition required to complete all six 3 -disc post-test problems also revealed a significant conditions effect in favour of those subjects trained in the paired situation ($t = 2.14$; $p < 0.025$).

There were 16 subjects of this age group who were classified as non-strategists at pre-test. 15 of these subjects progressed, adopting clear strategies at post-test. Of the 14 subjects who approached the problem strategically at pre-test 9 progressed and 5 regressed. All 5 subjects who regressed to non-strategic solutions were trained individually.

The Performance of 12-13 year olds on the Tower of Hanoi

Subjects in both conditions again showed a significant improvement in the number of moves they required to complete the three trials used at both pre and post-test (Individuals : $t = 3.19$; $p < 0.005$: Paired : $t = 4.22$; $p < 0.0005$). No comparisons between the conditions revealed any significant differences.

At pre-test only 8 out of the 34 subjects of this age group were non-strategists. All 8 of these subjects progressed to adopt strategic solutions at post-test. Of the remaining 26 subjects 19 successfully completed all the six post-test trials using the optimal seven move strategy.

The Performance of Subjects on the Logic 5 Problem

Table 6.3 THE MEAN NUMBER OF ENTRIES SUBJECTS REQUIRED TO COMPLETE THE FOUR POST-TEST GAMES OF LOGIC 5

Condition \ Age	7-8 yr olds	12-13 yr olds	Overall mean for each condition
Individual	M = 15.3 (n = 14)	M = 11.4 (n = 16)	M = 13.2 (n = 30)
Paired	M = 10.9 (n = 16)	M = 8.4 (n = 18)	M = 9.6 (n = 84)
Overall mean for each age group	M = 13.0 (n = 30)	M = 9.8 (n = 34)	

Table 6.3 shows the number of entries subjects of both age groups and in both conditions required on average to solve a Logic 5 problem at post-test. It is clear that subjects trained in pairs required fewer entries than those trained individually and also that the older subjects generally needed fewer entries than the younger ones. In fact subjects trained in pairs required significantly fewer entries than their same aged peers trained individually to complete the four post-test trials ($t = 4.16$; $p < 0.0005$). This was separately true both for 7-8 year olds ($t = 3.57$; $p < 0.001$) and 12-13 year olds

($t = 2.69$; $p < 0.01$). The older age group also performed significantly better than their younger peers at post-test ($t = 3.46$; $p < 0.0005$). This age effect was maintained when separately considering subjects trained individually ($t = 2.90$; $p < 0.005$) or in pairs ($t = 2.77$; $p < 0.005$). However, 7-8 year old subjects trained in pairs performed as well at post-test as the 12-13 year old subjects trained individually ($t = 0.037$).

THE ANALYSIS OF THE VIDEO RECORDINGS

The video recordings of the dyadic training sessions were initially transcribed verbatim. An analysis of the transcripts produced four major categories of task related statements. The first of these I have called 'proposals'. Statements of this kind were ideas for future action and usually consisted of suggestions for which number or numbers should be included in the next entry or which disc should be moved and to which pole it should be moved to. The second category I have labelled 'inference'. Statements classified under this heading were generally deductions arising as a result of the outcomes of previous actions. These frequently involved the clarification and interpretation of the feedback subjects received following an action and usually entailed comments deducing whether or not they had gained any insight into the problem's solution. For the Logic 5 task subjects frequently reflected upon whether a particular number must, as a result of the feedback, be correct or incorrect or whether or not a number was correctly positioned. These statements generally considered the existing state of play and were frequently followed by a proposal for further action. The third category was 'countering' statements in which one partner generally disputed a proposal or inference made by his peer. These indicated a clear difference of opinion usually concerning which course of action should be taken or what inferences could be drawn from the available information. Finally subjects would often 'refer back to past experience'. In these instances they would use feedback from previous situations to facilitate discussion on an existing situation. The videotapes were analysed and marked for these categories by myself

and an independent observer. Pearson correlation tests revealed inter-experimenter reliability for these categories of 0.81 for proposals, 0.78 for inferences, 0.85 for counters and 0.69 for references to past experience.

Table 6.4 shows the frequency of occurrence of each of these verbal categories for each dyad during their interactions. It reflects the extent to which verbal exchanges of this kind occurred for 7-8 year old and 12-13year old subjects who carried out the Tower of Hanoi and Logic 5 problems during training. It further shows the number of instances that each category of statement occurred during interactions for each task. Since the average length of the interactions for the Logic 5 task was on average nearly four times as long as those for the Tower of Hanoi it also indicates the length of each interaction and the accompanying number of utterances per minute. It is clear that there was a greater frequency of all categories of statements when subjects were engaged on the Logic 5 problem and that on average this task environment evoked over five times as many task related utterances per minute than that of the Tower of Hanoi. Furthermore, it was generally observed that the utterances related to the Logic 5 problem were longer and more developed than those occurring with the Tower of Hanoi. There was thus both quantitative and qualitative differences in the conversations that occurred in these different task environments. This data gives strong support for the hypotheses that the Tower of Hanoi and Logic 5 tasks would differ in the extent that they would generate task related discourse.

The frequencies with which these categories of statements were observed for the Logic 5 problem differed between the 7-8 year old and the 12-13 year old subjects. The older subjects made a significantly greater number of inferences ($t = 3.81$; $p < 0.0007$) and tended to suggest more proposals ($t = 1.86$; $p < 0.07$) and to make more references to past experience ($t = 1.81$; $p < 0.08$). There was no difference between the number of times subjects of these different age groups countered one another ($t = 1.08$).

Table 6.4 Analysis of Verbal Interactions.

where P refers to the number of proposals

I to the number of inferences

C to the number of counters

and P/E to the number of references to past experience

Task	(a) TOWER OF HANOI						
Subjects	P	I	C	P/E	Total	Time of Session (Min.)	Mean per Min.
7-8yr olds							
Pair 1	5	0	1	0	6	4.2	1.4
2	8	0	0	0	8	4.0	2.0
3	6	0	2	0	8	9.2	0.9
4	5	0	1	0	6	5.0	1.2
5	16	0	3	0	19	6.4	3.0
6	4	0	4	0	8	9.1	0.9
7	3	2	4	0	7	5.6	1.3
8	0	0	0	0	0	6.1	0.0
Total	47	2	15	0	62	49.6	1.3/min.

Table 6.4 continued/...

Task	(a) TOWER OF HANOI						
	P	I	C	P/E	Total	Time of Session (Min.)	Mean per min.
Subjects							
12-13yr olds							
Pair 1	2	0	3	0	5	8.1	0.6
2	7	2	0	0	9	5.4	1.7
3	0	0	0	0	0	5.8	0.0
4	5	0	3	0	8	4.6	1.7
5	5	2	1	0	8	5.1	1.6
6	4	0	1	0	5	6.2	0.8
7	1	0	2	0	3	7.2	0.4
8	0	1	4	0	5	5.1	1.0
9	0	0	1	0	1	6.1	0.2
Total	24	5	15	0	44	53.6	0.8/min.
Overall total for Tower of Hanoi	71	7	30	0	106	103.2	1.0/min.

Table 6.4 continued/...

Task	(b) LOGIC 5						
Subjects	P	I	C	P/E	Total	Time of Session (Min.)	Mean per Min.
7-8 yr olds Pair 1	41	8	18	12	79	25.4	3.1
2	54	13	33	14	114	21.5	5.3
3	61	23	40	9	133	20.4	6.5
4	55	29	4	7	95	24.8	3.8
5	40	6	4	3	53	23.2	2.3
6	57	8	32	7	104	26.1	4.0
7	60	14	20	3	97	21.0	4.6
8	40	10	14	4	68	18.4	3.7
Total	408	111	165	59	743	180.8	4.1/min

Table 6.4 continued/...

(b) LOGIC 5

Task / Subjects	P	I	C	P/E	Total	Time of Session (Min.)	Mean per Min.
12-13 yr olds							
Pair 1	40	20	16	9	88	18.8	4.7
2	52	30	23	9	114	20.0	5.7
3	58	26	18	12	123	26.0	4.7
4	76	27	47	12	162	25.2	6.4
5	74	52	40	21	187	24.3	7.7
6	95	45	52	31	223	23.7	9.4
7	41	26	5	4	76	15.7	4.8
8	61	18	18	6	103	18.1	5.7
9	49	34	17	10	110	23.7	4.6
Total	546	278	236	114	1186	195.5	6.1/min
Overall total for Logic 5	954	389	413	173	1929	376.3	5.1/min

A low correlation was found between a subject's post-test performance on the Logic 5 problems and the number of times he made a reference to past experience or heard his partner do so (0.40 and 0.36 respectively). Likewise low correlations were found between post-test performance and the number of proposals a subject made (0.59) or heard his partner make (0.35). A closer relation was found to exist between the number of inferences an individual made and his post-test performance (0.63) although this was not maintained in relation to the frequency with which a subject observed his partner making inferences (0.002). The frequency of a subject countering his partners viewpoint correlated highly with his later individual performance (0.74). although this was not the case for the number of instances in which a subject was himself contradicted (0.18). Furthermore, the number of instances during a training session when the subjects countered each other and then both defended their mutually contradictory positions was highly correlated with their pooled post-test performance (0.82). The greater the frequency of these confrontations the better the post-test performance.

The dyads can once again be viewed in terms of the relative dominance of its members for the Logic 5 problem. There were seven instances combined from both age groups of one subject tending to monopolise the exchanges and the decision making process to the exclusion of his partner. A subject was regarded as having dominated an interaction if he made at least twice as many task related utterances as his partner. These dyads were contrasted with more symmetrical interactions in which the partners contributed more equally to the exchanges. There was no significant overall differences found in the post-test performances of subjects who experienced these different kinds of social exchanges. ($t = 0.17$).

6.6 DISCUSSION

The first issue I wish to consider is whether the findings of this investigation suggest that peer interaction may stimulate individual

learning during a wider period of development than had previously been demonstrated. In order to do this I propose to consider the evidence for facilitation of individual performance as a result of interactions between peers for each of the age groups used in this investigation.

The youngest age group (5-6 year olds) worked only with the 3 disc Tower of Hanoi and not the Logic 5 problem. It was evident for this problem that no significant benefits were derived from working in groups as compared with working alone. An important feature of this youngest group of subjects was that over 80% of them approached this particular problem in an apparently random and non-strategic fashion at pre-test. In accordance with previous findings the vast majority of subjects who performed in this way improved their performance irrespective of the kind of training experience they received. Once again it appears that simply giving naive subjects the opportunity to practice a problem enables them to develop more organized approaches and that social interaction is not a necessary element for this transition. Perhaps the most parsimonious explanation of the improvement in these subjects performance is in terms of practice effects. By a process of trial and error they appear to be able to construct more strategic approaches to the problem.

This is not to suggest that social experience will never facilitate individual learning for this age group, indeed the paired training situation (as well as the individual situation) did produce improved individual performance at post-test. However, there was no evidence to suggest that social interaction results in any particular benefits when compared with the other non social training condition. It may be, however, that this reflects more upon the initial level of understanding of these subjects for this particular task, rather than upon any general limitations of social interactions for this age group. One would not expect naive subjects to portray coherent viewpoints with the result that there would be little likelihood of subjects either encountering or recognising discrepant viewpoints. Interactions between such individuals are thus unlikely to produce conflict situations which it has been suggested is an essential prerequisite to cognitive re-organization.

One may speculate whether the presentation of a simpler problem, for which these subjects possess at least a partial understanding, would have been more likely to produce socio-cognitive conflicts with accompanying benefits for subjects trained in a social situation. If this is the case it would reflect the importance of setting the problem at an appropriate level for the individuals involved.

Condition differences were clearly evident for 7-8 year old subjects presented with the identical Tower of Hanoi problems under the same training conditions. These subjects were more advanced than their younger counterparts with nearly half of them showing evidence of organized strategic behaviours at pre-test. Overall the social experience of working in pairs facilitated individual performance to a greater extent than did working alone for this age group. It seems likely that the benefits from social interactions accrues from the fact that the differing strategies being pursued by the two children lead to the making of moves inconsistent with those strategies. A child is thus led to (jointly) make moves which he would never otherwise have made, so that established inefficient strategies are disrupted. As a consequence of this disruption one or both of the children may see possibilities for better strategies. Interaction can thus be envisaged as a destabilising influence. It is worth noting at this juncture that social interactions also produced beneficial effects for this age group when engaged on the Logic 5 problem. These findings will be discussed in detail later in this section.

When one considers the performance of 12-13 year old subjects on the Tower of Hanoi problem one now no longer finds that there is a conditions effect. Peer interactions did not prove to be more facilitative of individual performance than working alone. However it was apparent that a majority (55.9%) of this age group, irrespective of the training they received, had discovered and were consistently utilizing the optimal solution strategy at post-test. Furthermore, another 23.5% of subjects intermittently adopted the optimal course of action during their post-test trials. The high standard of

performance by subjects in both conditions implies that problems of this level of complexity are well within their scope of comprehension. An understanding of the specific elements comprising this task was as easily achieved by subjects working alone as by subjects working in consultation with a peer. It may be that these findings cannot simply be interpreted in terms of the greater intellectual autonomy of these older children. Nor should they be taken to generally imply that interactions with others play no further part in the modification of thought for individuals of this age. Rather it may be that any form of intervention, whether social or not, cannot be expected to have much effect if the task is so straightforward that the optimal solution strategy readily becomes apparent to the majority of subjects. In fact, when confronted with the Logic 5 problem the situation was quite different for these same subjects. In this instance interactive experience was found to be significantly more facilitative of subsequent performance than working individually. Clearly these two tasks make different demands upon the subjects and, as will be discussed later, the nature of the exchanges that took place within dyads confronted with these tasks were strikingly different. However, one feature that may be of critical importance in determining the relative success of a social encounter in relation to either task is the initial level of understanding of the interactants. While the 3-disc TOH problem was not a sufficiently demanding task for this age group it appears that the Logic 5 problem was more suitable in that it presented greater difficulties and permitted greater scope for improvement. This suggestion must remain tentative since there was no accurate measure of the subjects pre-test level of understanding and any assessment of task difficulty can only be indirectly inferred from this session.

However, support for the claim that peer interaction will facilitate cognitive reorganization only when the problem is of an appropriate level of difficulty, namely when the subjects are neither naive nor fully conversant with the problem, can be directly inferred from the findings with the Tower of Hanoi. Thus for those subjects of all age groups who at pre-test showed no evidence of any organized strategic approaches to this problem there was also no evidence of particular

benefits being derived from the social training situation. Nearly all subjects of this level of understanding progressed as a result of either an individual or a social training experience. A different picture emerges, however, when one considers those subjects (again from all age groups) who were already at the intermediate stage of performance prior to the training sessions. For these subjects peer interaction facilitated the transition to a stable and optimal performance strategy to a significantly greater extent than individual learning. This suggests that social interactions may have particular benefits for subjects who possess partial understanding of a notion which are not found for more naive subjects. Furthermore, it is apparent that one would not expect to observe significant differential benefits as a result of specific training methods in those instances where the correct solution is obvious to most subjects concerned. This suggests that peer interaction may specifically facilitate cognitive change in those individuals who have at least a minimal understanding of the problem under consideration and as a result have both scope for improvement and can enter into a meaningful social exchange with another.

If this is true then the levels of understanding, for the specific problem being examined, that individuals bring to a social learning situation appear to be a more important factor than the age of the participants. In fact it may be that individuals of all ages benefit from the opportunity to co-ordinate their varying perspectives on a problem if their understanding is incomplete. The present investigation extended the age range under consideration and has produced some findings which suggest that social interactions may indeed,under certain circumstances, aid cognitive restructuring in individuals outside of the 'pre-operational' age range. Thus social interactions may be formative throughout the developmental process and not only in the breakdown of egocentric thought as suggested by Piaget. It is clearly possible to visualise suitable tasks for a wider age range, both older and younger, than the ones used in the present investigation. Further, investigations with these age groups are required to clarify this issue.

When discussing the changes in performance occurring as a result of differing training experiences it is important to consider the extent of these changes. In so doing I will only consider changes occurring in relation to the Tower of Hanoi problem since it was only for this problem that a clear assessment of both pre and post-test performances were obtained. The majority of subjects who were naive at pre-test and approached this problem in a random fashion, improved their performance at post-test. In the vast majority of instances progress was to an intermediary stage where subjects adopted organized strategic methods to solve the problem but did not consistently adopt the optimal solution strategy. This transition supports Piaget's (1977) proposed three stages of development for this task. 'Stage 2' being an intermediary stage between the earlier 'stage 1' trial and error attempts to solve the problem and the optimal 'stage 3' level where the subject consistently adopts the correct and most efficient strategy. The intermediate stage is characterised by organised solution patterns which, however, contain errors and modifications of the ideal strategy. Performances at this level clearly correspond to the use of the intermediate 9, 11 and 13 move strategies. While changes from stage 1 to stage 2 may support a structural and stage model of behaviour change, there were several instances in which subjects did not follow this sequence of change. Nearly one sixth of naive subjects progressed directly to the 'stage 3' level of performance and not to the intermediate stage. Transitions of this kind resulted from both individual and social training situations. Those instances related to the social training situation could not be accounted for in terms of an advanced peer guiding his less advanced partner. Of the four instances of this kind there was only one example where the individual's partner was fully conversant with the task. In fact there did not appear to be any common element in the experiences of the subjects who made this transition. It may be that, for this task, the optimal strategy is just one amongst a number and that there is no reason why some subjects may not stumble fortuitiously upon it. Once discovered it appeared however, that these subjects were able to stabilize its application and reflected an ability to accommodate it to new situations at post-test, when the starting and finishing posts were changed. Thus subjects who

made this transition indicated more than a superficial grasp of this strategy. The explanation for this transition is not clear and the number of observed instances too few to be suggestive of any hypothesis.

For those subjects who were already performing at the intermediary stage at pre-test progress was necessarily to 'stage 3' with the adoption of the correct strategy. A far greater percentage of these subjects made this transition after interaction with a partner as compared with those who worked alone. All those subjects who did not make the transition after social interaction remained at the intermediary level of performance. There was no evidence of subjects at this intermediary level of understanding who were confronted with other viewpoints, which were sometimes less advanced than their own, regressing to non-strategic approaches. In fact, in most instances there were clear benefits from these experiences. However, this was not the case for subjects trained individually. Not only did 80% of these subjects fail to progress butnearly a quarter of themregressed to random 'stage 1' approaches. It is possible that these regressions reflect failed attempts to change one's performance strategy. The destabilizing effect of these attempts producing an increase in uncertainty rather than an increase in understanding.

The changes in performance of a minority of subjects in this investigation may have important implications for a stage theory of behaviour change. The existence of instances of large improvements in the performance of some subjects and of regression in others suggest problems for such an approach. Clearly, further work is required to establish whether transitions of the former kind reflect the development of true understanding and whether those of the latter indicate a return to more primative levels of comprehension. It may be that performance changes of this kind are simply anomalies of this particular task or of individual subjects' performance or alternatively they may reflect limitations in the assessment measures used. This is clearly an issue requiring further examination.

I have previously suggested that while conservation tasks are

largely a matter of judgements and explanatations some of the other tasks used in peer interaction learning studies have been more concerned with the manipulation of concrete materials (e.g. Doise, 1978). The first issue I wish to consider in view of the qualitative analysis of the videotapes is whether there is any evidence to suggest that the two tasks used in the present investigation differed in the extent that they evoked verbal discussion. Prior to the investigation it was suggested that the Tower of Hanoi was largely a non-verbal manipulative task while Logic 5 was more verbally oriented. The findings of this study clearly support this proposal. Table 6.4 indicates that there was a far higher frequency of each category of verbal utterance measured, when subjects were engaged on the Logic 5 problem as opposed to the Tower of Hanoi problem. Overall subjects faced with the Logic 5 task made over five times as many task related verbal statements as the same subjects confronted with the Tower of Hanoi task. This finding gives strong support to the proposed close relationship between the task environment and the nature of the related social interaction. Subjects engaged on the Tower of Hanoi problem were largely involved with the joint manipulation of the discs and produced on average only one task related utterance per minute. However, when confronted with the Logic 5 problem these same subjects engage in a far greater amount of verbal discourse with over five task related statements occurring on average per minute. This suggests that in this instance the verbal medium will play a more crucial role in the transmission and resolution of discrepant opinions.

In the preceding chapters I proposed that two elements suggested themselves as important in the resolution of conflicting positions : verbal reasons and explanations on the one hand, and active hypothesis testing with concrete materials on the other. Prior to this investigation the studies reported in this thesis have placed less emphasis on verbal discussion than other authors have done. This is not because such discussions are seen as irrelevant to the value of peer interaction but rather that the importance of verbal as against practical interaction is seen as very much dependent upon the nature

of the task involved. Either or both may contribute to the perception and resolution of conflict. However, the nature of the Tower of Hanoi task used in the previous investigations has emphasised more non-verbal aspects of the interactions. In other investigations the importance of verbal explanations has perhaps been clearest in the case of investigations of asymmetrical interactions (e.g. between a conserver and a non-conserver). There is evidence to suggest that conservers are likely to give reasons to defend their position and to produce counter arguments, and indeed, Doise, Mugny and Perret-Clermont (1975) found that the cases where this occurred were those most likely to result in gains by the non-conserver. Doise (1978) again emphasised the role of verbal exchanges, but seemed to see their role more in terms of the presentation of conflict than in terms of its resolution.

Clearly it is important to clarify whether social conflict can be directly established as an important element for some cognitive reorganization. Researchers have generally given little attention to directly observing and verifying the existence of conflict during interactions, nor to establishing the proposed relationship between socio cognitive conflict and individual progress. This is clearly most easily achieved by considering the verbal exchanges that take place when children are engaged on appropriately verbally oriented tasks. I shall, therefore, consider these issues as well as the question of how conflicts of opinion are resolved in the light of the qualitative analysis of the videorecorded interactions of subjects engaged on the Logic 5 problem.

Strong evidence of verbally transmitted conflict was in fact found for subjects working with the Logic 5 problem. There were 413 instances of one member of a dyad verbally countering his partner, which on average means that there were about 24 instances of verbally expressed conflict per training session. Clearly subjects faced with this problem were frequently confronted with opinions discrepant from their own. Furthermore, the frequency of an individual perceiving a conflict of viewpoints and as a result countering his partner's position

correlated highly with his individual post-test performance. The number of times a subject was countered by his partner was not closely related to his post-test performance. This was not wholely unexpected since there is no guarantee that the recipient of a counter will recognise the fact that a disagreement exists, nor that if he does that he will be able to understand the nature of the conflict involved. However, the act of countering implies both the recognition of an opinion with which one disagrees and an attempt to defend an alternative perspective to the problem.

A subject who recognises a conflict situation and feels compelled to verbally represent his own viewpoint may, as suggested earlier, gain some benefit simply by clarifying his own position (e.g. Gagne and Smith, 1962 ; and Marks, 1951). If, however, his partner is unresponsive or submissive to this declaration then there does not appear to be any reason for him to consider alternative approaches from his own. The situation may be different in instances where both partners recognise the conflict and both defend mutually exclusive positions, then the conflict situation may act as a catalyst for the formation of new approaches to the problem. The present investigation found some support for this proposal. A high correlation was found between the number of instances in which both partners countered each other and defended their discrepant viewpoints with inferences and references to previous experiences, with their joint post-test performance. The greater the frequenty of mutual conflict and argument the better the post-test performance. On such occasions it is evident that both partners have perceived the conflict. They attempt to resolve their disagreements via verbal arguments and explanations with each subject attempting to justify their own position against that of their partner. Generally, two outcomes were observed. Either one individual's position prevailed or a new compromise view was agreed. In many instances it appeared that both partners were not convinced that the agreed resolution was necessarily the correct one but were both willing to test it out as one possibility. In either case the dispute may not have come to an end. A proposal may be agreed to and tested out

but may not produce the expected outcome. In which case new proposals may arise or old ones may be revived. This results in a kind of ongoing process of disputes, accompanied by arguments, justifications and explanations, followed by a decision and testing procedure.

This process of continuing disputes which are partially or fully resolved by testing out possibilities and then reassessing the situation is demonstrated in the following two extracts from interactions with the Logic 5 problem. In the first example Nyree and Greta are attempting to find the third figure to complete the correct three digit number.

VERBAL DISCOURSE	ASSOCIATED INFORMATION
G. We only got one, one ; so that means the 9's there ... and the 5's there and put in the 6.	Refers to previous guess where one number was correct and in the right position. Tries 965 : gets two numbers correct and in their correct positions.
N. Sot it must be the 9 and the 5. No, No it can't be. Yes, so it must be the 9 and the 5 so (pause). What number haven't we tried?	
G. The 5's definitely right.	
N. We haven't tried 4.	
G. No but that was one, naught and we reckon that 5's there so it can't be 4. We got one right there, it could be the 1. Ah! no there was a 5 again.	Refers back to earlier guess which contained a 4 and a 5. Again looks back through the record of previous entries.

N. Perhaps we could try the 2.

G. Hang on ; we've got the 3 and the 5 there ; it could be 935. — Again refers to a previous entry.

N. You don't know what you're on about.

G. We got two numbers right there and one of them is in the right place. — Again looking back.

N. Yeh, two of them, so it's the 9 and 5.

G. How do you know its 5 though?

N. It must be because every time we've tried it we've got one right. Haven't we?

G. Hmm.

N. So if we try another number in the middle. How about 0?

G. So what shall we put? 905?

N. Yeh, it's my turn. — Enters guess and gets two numbers correct and in their right place.

N. So it can't be 0. Let's try 8. Yeh the 8. — Looks back at past guesses.

G. No, that can't be in it.

N. Yeh, but it could be the one in the right place. Referring to previous entry.

G. I think 5 is in the wrong place.

N. It can't be. Look try 8 cos we haven't tried the 8 there yet. Go on just try 8.

G. OK I think the 9 and 5 must be right. But you've got a number missing. I don't know what it is. I'm just guessing. If its the 9 and 5 then it can't be the 4, or 2 or ... Let's see what numbers we've had. Surveys the previous entries.

N. Look we've got two right there and one is in the right place. It must be the 8 cos we got none right there. Looking through the previous entries.

G. Yes.

N. Try 985. This is the correct number.

In the second example Carla and David are trying to decide if the number six is one of the figures they are looking for in the target number.

VERBAL DISCOURSE	ASSOCIATED INFORMATION
C. It's got to be 9.	
D. No, No, there might be a 6 in it.	
C. Yes, it must be 6 ; 6 is in the middle, so put 6.	
D. Hey look! it's got to be 1, 6 and 9. So we've got to rearrange that. Let's put 1 at the end.	Looking at previous entries.
C. 6 in the middle.	
D. No. 6 has been in the middle.	Points to a previous example.
C. Yeh, but then it was in the right place.	
D. Come on then, try 961.	This shows one number correct which is in its incorrect position.
C. It must be the 6.	
D. It mustn't be.	
C. It can, It's got to be the 6. It's got to be 6 in the middle. Try 362.	
D. But if it was in the middle it would have been one, one. Wouldn't it? Look we got naught there, its definitely got to be another number.	Refers to previous entry. Points to a previous entry.

C. Well it's got to be 6 hasn't it. Put 6 here.

D. It hasn't. It's one of those three numbers, none of those numbers, one of those numbers and one of those numbers. Examines some previous entries.

C. Yes, and every time we've put 6 in the middle we've got one in the right place.

D. No! Look you said every time we put 6 we got one in the right place. Points out a contradictory example.

C. Yes, look we got the right numbers but it was not in the right place. So its got to be in the middle and its got to be number 6.

D. So what are the other numbers?

C. I don't know.

D. So you think it's the 6, We have not had 617.

C. Try it. Produces two correct figures one of which is also in its correct position.

D. Hang on. Two of those numbers are right and here we got two numbers and they were in the right place. Looking back to previous entry.

C. So it's got to be 6 and 7; hasn't it?	
D. It doesn't have to be. It must be 7 and 1. Look they were right here as well.	Points out a previous entry to support his position.
C. OK. Lets try 9. Try 917.	This produces two correct figures one of which is also in its correct position.
D. Right, 6 isn't in it.	This is correct.

It is clear from the previous extracts of interactions that subjects are coming into conflict and attempting to resolve their disagreements either by presenting arguments and explanations in favour of a particular viewpoint, or by referring to feedback from entries earlier in the game which support their position and contradict their partner's. In some instances where one viewpoint does not clearly prevail they may agree to test out one of the available possibilities. Without both partners necessarily being convinced that it is correct.

However, it is only with some reservation that the data can be taken to support the proposal that socially resolved conflict underlies cognitive change occurring as a result of interactions between peers. Due to the difficulties in pre-testing children on the Logic 5 problem no individual baseline measure of performance was obtained. This necessarily means that no consideration could be given to the subject's improvement in performance, but only to their actual level of post-test performance. As a result an alternative interpretation of the present findings is possible. The high correlation between the frequency with which a subject counters his partner during an interaction and his post-test performance may not necessarily imply

a critical formative role for the conflict that the subject experiences, but simply that the more advanced the subject is, the more likely he is to contradict his partner. It may also be that the more advanced subjects are more likely to defend their position more and thus to be involved in mutual conflict. In fact some support for such an interpretation may be derived from the description of interactions between conservers and non-conservers given by Miller and Brownell (1975). They demonstrated that the more advanced conservers were more likely to assert their answers and to produce counter arguments. However, the situation is not so clear cut in the present investigation. The Miller and Brownell argument that conservers exert a strong influence during an interaction due to the greater conviction with which they hold their viewpoint relative to a naive partner, may not be as relevant in an interaction between two subjects neither of whom are fully conversant with the problem. One may, in fact, indirectly find some support for this proposal. If one assumes that the older children in the present investigation were more advanced than their younger peers (no accurate pre-test measures were made) then one may expect these subjects, according to the Miller and Brownell argument, to counter their partner more frequently than their younger peers. However, this was not the case although they did make significantly more inferences and tended also to make more proposals and references to previous experience. This may suggest that the frequency of countering, in this instance, was not only the result of the initial level of the subject's understanding but was a formative element in developing further understanding. Clearly, however, further investigation is required to clarify this issue.

There is one further issue to which I wish to devote some space. This is the question of whether dominance within an interaction has differing effects according to the nature of the problem being considered. It was demonstrated, in previous investigations, that where one member of a dyad dominates an interaction concerned with the largely non-verbal Tower of Hanoi task then this will disrupt any individual benefits that may have resulted from the social experience. This, however, was not found to be the case in the present study for the

more verbally oriented Logic 5 task. In this instance no significant differences were found between the post-test performances of those subjects who were in an interaction in which one member dominated and one was submissive as compared with subjects who engaged in more symmetrical encounters. Clearly with a verbally oriented task there is the possibility for a dominant subject to defend his viewpoint with arguments and explanations. These may enable his submissive partner to gain insight into an alternative viewpoint from his own and to resolve the discrepancy in favour of one or the other position. With more non-verbal tasks, on the other hand, while the submissive partner may be able to identify a conflict of vi ewpoints is is unlikely that he will be able to gain any insight into their relative merits since his dominant partner will be unable to provide any verbal justifications for his behaviour. Thus, the submissive partner may be unable to resolve any conflict he experiences with the result that he makes little individual progress. For either kind of task there is little evidence to suggest that the dominant individual will progress as a result of asymmetrical interactions of this type. These individuals may never encounter a contradictory position from their own, and if they do they may simply be able to ignore it since their partner is unlikely to defend their viewpoint. In nearly all instances their viewpoint will predominate with the result that there is little obligation for them to consider alternative approaches from their own.

To summarise I will briefly relate the major issues that have been considered in this investigation. Firstly, it has been suggested that social interaction can facilitate improved understanding over a range of ages provided that the task is at an appropriate level for the subjects involved. It appears that subjects part-way towards an understanding of a problem will benefit most from interaction with their peers. Secondly, it has been emphasised that the structure of a task will be an important factor in determining the kinds of exchanges that occur during an interaction . Furthermore evidence has been presented which supports the proposal that conflict does occur during interactions between peers and it has been suggested that the manner in which these

conflicts are resolved is also partly task dependent. Finally, it has been proposed that conflict and its resolution are intricately related to individual cognitive re-organization although the findings related to this issue remain somewhat ambiguous. Several of these issues will again be considered in detail in the final chapter.

CHAPTER 7

AN OVERVIEW OF THE FINDINGS AND A LOOK TO THE FUTURE

7.1 INTRODUCTION

Under certain conditions social interactions between peers, which require a co-ordination of actions or points of view can bring about a modification in the individual cognitive structures of the participants, which would not have occurred if the subjects worked alone. My thesis has been concerned with the experimental demonstration of this effect. It has examined some of the factors which facilitate the observed changes in performance and has indicated possible explanatory mechanisms.

The results presented have already been discussed in detail as they were reported. This concluding chapter will, therefore, be confined to an overall review of the findings and their implications for the theoretical issues set out in Chapters 1 and 2. I will also consider the direction that future research may take along with some of the implications that this work may have for educational practice. However, I wish to preface these considerations with a few general comments about some limiting factors which may determine how productive any interaction may be.

7.2 LIMITING FACTORS

Several experiments have been reported which indicate cognitive benefits for children as a result of social interactions with their peers. However, it was evident that children did not benefit from these experiences in every instance and there were several variables which were clearly influential in determining the success or otherwise of these situations. Three limiting factors were clearly established :

(i) the initial level of understanding of the subjects ;
(ii) the roles adopted by the subjects during the interaction, and
(iii) the structure of the social situation imposed by the experimenter.

The level of understanding subjects possessed was an important factor in determining whether or not they would derive significant benefit from an interchange with a peer as compared to working alone. [illegible] have presented some findings which suggest that children of lower cognitive levels benefit more from social interaction than do advanced children. However, my findings have suggested that if one compares the performance of children trained socially with those trained individually, then this may not be the case. The evidence I have presented indicates that poorer subjects quantitatively make more progress than their more advanced peers. However, they appear to progress in any training situation, whether social or non-social, which enables them to practice upon the problem. Only the more advanced subjects were found to benefit significantly from a social training situation relative to a non-social one. I have suggested that relatively naive subjects are unlikely to derive particular benefits from a social experience as a result of the limitations imposed upon them due to the absence of any coherent viewpoint. For a child to enter into a meaningful and productive social exchange with the possibility of entertaining differences of opinion with another, he must have at least a minimal level of understanding of the problem being considered. Otherwise he is unlikely to be able to offer profitable suggestions or to formulate constructive questions and he may also have difficulty in understanding the strategies of a more advanced partner. In these circumstances it is not surprising that naive subjects are unlikely to derive any special benefits from a collaborative effort to solve a problem. It was evident that subjects must have at least a partial understanding before they can engage in a meaningful social exchange and it was these individuals who gained significant benefits from social training experiences. The profit for these subjects accrues from the fact that the differing strategies being followed by the two children lead them to entertain ideas inconsistent with their original strategies. As a result each child comes to consider possibilities which he would never otherwise have made, so that his previously established and inefficient strategies are disrupted. As a result of this destabilising influence one or both of the children may resolve the situation if they see possibilities for better strategies.

The roles adopted by children during an interaction were also found to be an influential factor in determining the resulting extent of individual progress. However, the extent of the influence of this factor was dependent upon the nature of the task being considered. When subjects were engaged on a manipulative rather than a verbally oriented task, then it was observed that if one member of a dyad adopted a dominant role and his partner a submissive one, then little individual gain resulted for either individual. This finding is in harmony with those of Doise (Doise 1978 and Doise and Mugny 1979). Doise observed that dominance was a disruptive element when subjects were engaged on a predominantly manipulative and non-verbal spatial transformation task where a conserving child excluded his non-conserving partner from the interaction (Doise and Mugny 1979). He further found that introducing status differences in a motor co-ordination task inhibited the progress made by the lower status subjects (Doise 1978). Doise and other authors (e.g. Miller and Brownell, 1975) have observed that dominance frequently occurs in instances where a child who is fully operational on a task is paired with a naive partner. Miller and Brownell argued that operational subjects dominate as a result of the greater conviction they possess in their viewpoint relative to their non-operational peers. The research I have undertaken with the Tower of Hanoi has further indicated that dominance may occur and be disruptive during dyadic interactions in which neither partner is fully conversant with the problem. In this instance it is not always the more advanced child who dominates, rather it appears that the personal characteristics of the interactants may be the determining factor as also suggested by Russell (1982). Generally, interactions concerned with manipulative problems are most profitable when subjects mutually collaborate in their attempts to solve the problem.

However, it appears that the situation may be quite different when subjects are engaged on a task, like 'Logic 5', which is more verbally oriented ; for which verbal descriptions, judgements and explanations are appropriate. In this instance dominance was not found to disrupt individual progress. Although once again neither subject

was fully conversant with the problem, this finding appears to be in harmony with those indicating progress by submissive non-conserving subjects after an interaction with a dominant conserving partner while engaged on a problem of conservation (Miller and Brownell, 1975 ; Silverman and Geiringer 1973 ; and Silverman and Stone, 1972). Conservation problems can also clearly be verbally defined and explained. For tasks of this nature it appears that both interactions which entail dominant and submissive individuals as well as those in which the partners collaborate more equally, can facilitate individual cognitive reorganization.

Finally an important factor in determining the relative success of an interaction was the external structure imposed upon the social situation by the experimenter. These limitations were particularly important for the individuals involved since the emphasis was upon subjects formulating knowledge for themselves. Clearly any restrictions could be influential in this process. As was pointed out in Chapter 5, if subjects are to participate actively in learning it is essential that the evidence on which their suggestions and hypothesis are to be based should be under their control. The task for the subjects is essentially to reinterpret their experience and to elaborate and develop new ideas by recoding them to one another and themselves. Clearly such a process is aided by free and uninhibited access to the problem. In the situation where the experimenter removed their control and took on the role of provider of information, then the social situation was unproductive for the individuals involved. Clearly, however, while permitting the subjects control within their situation the experimenter can direct the subject's attention to a task in different ways, and can structure the roles they adopt to a greater or lesser degree. It was evident, for example, in relation to the Tower of Hanoi problem, that the most successful situation was one which was highly structured and co-operative which facilitated individual progress more than less structured or competitive situations. The external restrictions imposed upon the social situations clearly produced significantly different degrees of progress and overall qualitatively different strategies resulted from these different conditions. Evidently

it is important when assessing subjects performance to be aware of the context within which it occurred and to be sensitive to the limitations created by the experimental setting. I will say more about this issue later in the chapter.

I have considered some aspects both of the subjects themselves and of the social setting which influence the success of an interaction. I now wish to turn my attention to particular elements of the social exchanges which appear intricately related to any individual cognitive gain which results and which suggest possible mechanisms by which these changes are brought about.

7.3 THE RESOLUTION OF CONFLICTS AND COGNITIVE DEVELOPMENT

In Chapter 2 I distinguished modelling studies, which developed within the realm of social learning theory, from active interaction studies which developed in the context of Piagetian theory. Within the latter category I have further distinguished those which are concerned specifically with the effects on a child of interaction with a more advanced partner from those which are concerned with the effects on both partners of more symmetrical interaction. A unifying element in all these cases is that subjects are exposed to a conflicing viewpoint. The hypotheses advanced by researchers to date to explain observed changes in performance by subjects after a social encounter, have largely been concerned with the mode of transmission and perception of this conflicting view. Whether, for example, it is sufficient for the child to passively observe a conflicting view expressed, or whether it is necessary for that view to be expressed verbally, and so on. However, this emphasis on mode of transmission of differing opinions may be misplaced. During an encounter, without any arbitrary restrictions, one or several means of transmitting potentially conflicting viewpoints may occur. However, from the perceiver's point of view there is no reason to suppose that one mode of transmission will be any more potent than another. A viewpoint discrepant from one's own will always be potentially unexpected and disturbing independent of how it is perceived.

Less attention has been given by researchers to the question of why experience of conflicting views should facilitate learning. It has been variously suggested that the child succumbs to the greater conviction with which the 'operational' view is held (Miller and Brownell 1975) ; that the subject's tendency to model himself on the other produces a cognitive dissonance resulting in cognitive growth (Botvin and Murray, 1975) ; or that socially percieved conflicts between different centrations leads to co-ordination of those centrations (Doise, Mugny and Perret-Clermont, 1975). However, such proposals leave it far from clear why such changes as a result of an apparent state of confusion and inner conflict should be accompanied by an increased understanding of the disputed notions. The work presented in this thesis has several implications for this question.

Both the social learning view that tries to explain the child's acquisition of behaviours by processes of imitation and the social influence hypothesis of Miller and Brownell (1975) suggest that a less advanced partner will adopt and maintain the viewpoint of a more advanced peer. However, in many instances this does not appear to be the case. A subject's post-test performance not only appears to be determined by his partners level of performance, but also by his own pre-test level of performance. Frequently, the observed change is to an intermediate level although the subject did not observe his partner perform in this way (e. g. Kuhn, 1972 and Murray, 1974). In Chapter 6 I reported findings that support this view. Furthermore, social learning theory and its process of imitation do not enable us to explain why models demonstrating less advanced behaviours are not imitated. If children were fashioned in the image of the behaviours which occur in their social environment, the presentation of less developed models, or interaction with them, should bring about regression. On the contrary, however, my work has shown that in certain cases children are impermeable to such influence, or, more remarkably, that they can even draw profit from interactions of this kind. The only evidence of regression observed occurred with subjects who worked alone.

Kuhn's (1972) equilibration model, according to which all cognitive change comes about through a process of restructuring, overcomes the difficulty of non-regression. Kuhn attampted to show that the social model is a source of cognitive change for the subject, but that the model does not provide a form of thought for the child to imitate, rather it stimulates cognitive change in the 'natural' direction of development, generally to the next higher developmental stage. In this account it is the contradiction between two sets of behaviours that creates a cognitive disequilibrium for the subject. Then it is the process of internal reorganization thereby set in motion which brings about operational change. According to Kuhn the re-structuring can only lead to a more advanced stage of development. I t was this conceptualization which allowed Silverman and Geiringer (1973) to explain why, following an interaction between conservers and non-conservers, the latter progress and the former do not regress. Such a model is able to explain why subjects performance may change without invoking the further implication that this change should be towards the observed behaviour. It is also able to offer an explanation of non-regression in subjects exposed to less advanced behaviours. The formulation is explicitly inspired by Piagetian theory. However, the role it accords to the superiority of the model indicates too narrow an interpretation of the interactionist and constructivist conception of development put forward by Piaget.

The investigationss reported in this thesis have repeatedly supported the principal findings of Doise and his colleagues - peer interaction being reliably superior to individual experience on a task. Furthermore they have supported the proposal (Doise, Mugny and Perret-Clermont, 1976) that a child need only be confronted by another who holds a different viewpoint and not necessarily by one who holds the correct or even a more advanced viewpoint in order to improve their understanding. In fact it has been demonstrated that it is neither necessary nor sufficient to be exposed to an advanced model. In the instruction condition described in Chapter 5 children were not only shown the optimal solution to the Tower of Hanoi problem but were permitted the opportunity to practice it under the direction of the experimenter. In this situation no explanations

were provided to justify this solution strategy. This experience did not produce significant progress relative to an individual control group. However, significant individual gains were found for subjects, neither of whom fully understood the problem, who freely interacted with each other in their attempts to solve the problem. Furthermore, it was found that the less advanced member of a dyad frequently progressed beyond the initial level of understanding of his more advanced peer and that the more advanced partner himself, in many instances, also showed evidence of progress. These findings are clearly inexplicable in terms of a simple modelling effect since neither member of the dyad adopted the viewpoint of his partner. Furthermore, instances of progress by the more advanced member of a pair would not be predicted by either the Kuhn (1972) model nor by the social influence model proposed by Miller and Brownell (1975).

The fact that these hypotheses cannot accommodate findings of this nature suggests that other aspects of the interaction are important to explain the performance changes observed. I have advocated inter-individual conflict as a central element in this issue. In Chapter 6 the existence of conflict during interactions between peers was clearly established and evidence that the frequency of its occurrence correlates highly with individual post-test performance was presented. Conflict, as has been pointed out, is clearly a potential element in all the social situations studied by experimenters, and the most parsimonious explanation for any observed improvement in individual understanding resulting from these social situations may reside in the common element of conflict present in these situations. Thus the child in a modelling situation can be viewed as encountering a conflict between the behaviours which he or she would have deployed in relation to the task, and the behaviours observed. Similarly interactions between conservers and non-conservers can be viewed as a specific instance in which cognitive conflict may arise. The social influence hypothesis suggests a likely reason why the viewpoint of the conserver may predominate. However, it fails to adequately account for why cognitive change and an increase in understanding may, in some instances, occur for the less advanced member of the dyad.

It is evident that the proposal that inter-individual conflict is a central element in the development of understanding resulting from interactions between peers, shares much in common with the 'conflict' model of Doise and his associates. However, there is an important respect in which they differ. Doise has said little about what happens after conflicts arise. He has argued that as children centre on different aspects of a task they come into conflict and will attempt to co-ordinate their different centrations resulting in cognitive reorganization. However, the exact form that this process of co-ordination takes remains unclear.

The investigation described in Chapter 5 established that conflict is insufficient by itself to produce cognitive restructuring and I suggested that it must be accompanied by the opportunity for the disagreement to be resolved. I emphasised conflict resolution as a central and necessary element for the transition between socially encountered conflict and cognitive re-organization. If a child is to develop greater understanding of a notion as a result of confronting opinions discrepant from his own, he clearly needs the opportunity to discover reasons why one viewpoint may be better than another. Two factors were suggested as important for the resolution of conflicts : verbal reasons and explanations on the one hand, and active hypothesis testing with concrete materials on the other.

Verbal explanations in defence of particular viewpoints appear to be a particularly compelling and persuasive means of resolving disagreements and developing understanding. In Chapter 6 I presented evidence which showed that the frequency with which both members of a dyad come into conflict and both attempt to explain and defend their discrepant positions, is closely related to their later individual levels of performance. Verbal reasoning and description of this form clearly enables the participants to gain greater insight into alternative perspectives from their own. Discussions of this kind may force a child to reconsider his own position in favour of his partner's or in cases where both partners defend their antagonistic positions then new, perhaps compromise approaches may arise. A particular instance in which

the importance of verbal explanations is clearly demonstrated is the case of asymmetrical interactions between conservers and non-conservers. Several authors have provided evidence (see Chapter 2) that conservers are likely to give reasons and produce counter arguments to defend their viewpoint, which is then likely to prevail over that of their less advanced partner. Indeed, Doise, Mugny and Perret-Clermont (1975) found that those instances where this occurred were the most likely to result in gains by the non-conserver, thus once again emphasising the importance of verbal discussion and explanations.

An alternative means of resolving conflict is by active manipulation of concrete materials. As a result of the investigations carried out with the Tower of Hanoi problem I have suggested that it is possible for a child to engage in hypothesis testing and to resolve conflicts of opinion through action. This is in harmony with Piaget (1970) who contends that it is only through active manipulation experiences, where the child projects and verifies hypotheses of his own invention, that true learning will occur. Again this actively provides the opportunity for subjects to clarify and understand alternative approaches to a problem.

A further implication of these proposals is that the means of resolution of conflict is task dependent. It has been clearly demonstrated that tasks differ in the extent to which they evoke task related verbal discourse. While tasks such as the Logic 5 problem and conservation problems are largely a matter of judgements and explanations other tasks such as the Tower of Hanoi and the motor co-ordination task utilized by Doise (1978) have primarily involved children in manipulating materials. The nature of these different kinds of task place different limitations upon the kind of exchanges that can occur. They also predispose subjects to adopt certain kinds of methods to solve the problems and hence also to resolve any disagreement occurring between subjects. The importance of the nature of the task in the study of the social parameters of peer interaction underlying the development of understanding is a factor yet to be fully considered in this area of study.

However, it is an issue to which further attention will have to be paid as the form that a social exchange takes will clearly be at least partly dependent upon the issue being considered.

7.4 SOME GENERAL CONSIDERATIONS

I now propose to devote some space to a consideration of some general theoretical issues. By focussing my attention on the issue of the role of peer interaction in cognitive development I have not wished to suggest that all knowledge is necessarily socially constituted. For example, one can envisage an individual encountering conflicting feedback in the course of some isolated consideration of a problem which may facilitate cognitive restructuring. In fact a number of studies (e.g. Brainerd and Allen, 1971 ; and Miller, 1971) have reported positive training effects from the presentation of disconfirming feedback. Furthermore, in advocating conflict and resolution as a means through which social interactions may facilitate understanding I do not wish to rule out other possible social mechanisms of change. For example, under certain conditions imitation may act as a vehicle for the exchange of knowledge between individuals. However, this process appears to have limitations as a basis for the development of understanding, as reported in Chapter 2.

In focussing my attention on these issues I have attempted to examine the effects of a particular kind of experience on cognitive development and to suggest possible mechanisms underlying any progress occurring as a result of these experiences. While Piaget's highly influential theory has attempted to describe the basic features of cognition as it develops, it has paid relatively little attention to the role of specific kinds of experience in fostering that development nor to the mechanisms underlying the transition between different modes of thought. However, psychological theory must be concerned with an examination and indication of the influence of specific kinds of experience in prompting development and of the processes involved in it. The work presented in this thesis has suggested socially engendered conflict and resolution as important elements in at least some kinds of developmental change.

This work further implies a close liaison between social and cognitive aspects of development which have traditionally been treated as separate and distinct. In Chapter 1 I emphasised the importance of the social context in which most cognitive development occurs and suggested that social interactions appear to play a special role in the early development of the neonate. It seems reasonable to assume that an individual's relationships with others continue to play an important role in his development and it may be that contradictions of a social nature are especially likely to occur in the environment of the young child. Such conflicts afford the opportunity for the young child to be simultaneously faced with two discrepant viewpoints and also with another individual who may defend an alternative viewpoint to his own. It appears that social experiences of this kind will be formative in the child's developing understanding of the world around him as well as his understanding of social relations.

In our investigation of these issues it is important that we fully recognise the complexity of the learning situations we observe as psychologists. As Cole and Scribner (1974) have pointed out we have tended to regard two children who are arguing as the subject matter of social psychology, whereas if the same children are solving a maths problem it becomes 'cognitive development'. In future work it is clear that we can no longer simply dichotomise situations into social and non-social, whether they involve a child working alone or with others on a problem. The ways that children handle the tasks which adults set for them do not always reflect the way in which the adult views them. The child's performance may not only be determined by the way he interprets the task but also by the various social parameters which form the social context of that particular experimental situation. One possible consequence of this is made explicit in the work of Labov (1972) and Katz (1973). They revealed how the quality of a subject's performance is sensitive to the social relationship obtaining on the occasion of its elicitation. The performance is richer when the individual is at ease in his relations with the experimenter. The situation will be further complicated if the child is not working

alone so that his relationship with others may become an important and influential feature of the learning situation. While social interactions may sometimes be associated with problem solving they are also frequently related to the establishment, development and clarification of relationships. If our knowledge of others arises through a recognition of the similarity between ourselves and others, then clearly disputes of any nature may be formative in a developing relationship. It should not be surprising, therefore, if disagreements about how to approach a problem may not only be viewed in terms of different, and perhaps incompatible, viewpoints which require co-ordination but may also be interpreted as reflecting upon the nature of the participants' relationship. Once again it is apparent that these situations cannot simply be viewed as either involving the development of thought or with the development of social understanding. Elements of both are intricately interrelated so that when a child is exchanging ideas about a problem it is also likely that he is learning about his partner and perhaps developing their relationship as well as his own social knowledge.

The child uses a variety of cues to relate new experiences to what he already knows. This sensitivity to cues may determine which features of a situation gain priority. It is our task as developmental psychologists to try and understand how the child uses these cues in order to better understand which experiences facilitate cognitive change.

7.5 PEER INTERACTION IN EDUCATION

Research on child-child interactions as a major facilitator of learning has obvious practical implications for group work in the classroom. Piaget (1932) observed that the strictly individual work which he saw as characteristic of traditional schools ran contrary to the most obvious requirements of intellectual development. The concept of the traditional school is exemplified by a system that imposes work and where, according to Piaget

> "the students intellectual and moral activity remains heteronomous because it is inseparable from a continual constraint exercised by the teacher". (1950, p.151).

He suggests that an education which is an active discovery of reality is superior to one that consists merely in providing the child with ready made truths.

Several other authors have also emphasised the contrast between teaching practices emphasising 'active learning' and those emphasising 'presentation learning' (e.g. Almy, Chittenden and Miller, 1966 ; Chittenden, 1969 ; Ginsberg and Opper, 1969 ; and Schwebel and Ralph, 1973). In fact, the practices of presentation learning which are still current in many schools arise from a method of collective teaching which addresses itself simultaneously to all the children in a class through the medium of presentations. This method of teaching has many similarities to the presentation of models which have been studied experimentally. While it would seem difficult for this kind of approach to capture all the children's attention and interest, it is even less possible for it to accommodate the individual differences in levels of understanding. Furthermore, the findings of modelling studies suggest that interventions of this type may have only limited beneficial effects. Clearly in situations where teaching is more individualized then a real communication between the child and the teacher is possible, which permits social interaction on the cognitive level. However, due to practical limitations a teacher may be unable to enter into a communication with each individual child. But may not the same thing be facilitated by interactions among children, which has been demonstrated to be a potential source of development ?

In fact it is evident that teachers do widely use group learning situations, indeed the exigencies of equipment and laboratory space force group methods on most secondary science teachers. However, one suspects that many teachers have never considered the full implications of why their pupils may profit from these experiences. In reality most group work in schools appears not to be founded on a

well established theoretical base although an understanding of the functioning of such groups is clearly a necessary prerequisite for the optimal management of these learning situations. Most educational projects that have concerned themselves with the investigation of children working together have addressed themselves to the situation of one child tutoring another, even though tutoring is relatively little used in schools. Furthermore, as we shall see, the findings of these studies have generally been inconclusive. The reasons for this are best explained by viewing this research in a historical context.

The idea of children tutoring each other cropped up within the cultural transmission ideology. This draws from the classical Western tradition of learning, which consists of imparting existent knowledge and inculcating cultural values and democratic ideas. Education is seen as the transmission of what is known and what is accepted as important to the culture. Knowledge in this sense, is therefore relatively static and society oriented. Cross-age turoring began almost unawares as a practice, rather than a concept. The goal was to provide academic knowledge to a younger child and physical assistance to the overburdened classroom teacher. The emphasis then shifted to the older child, the tutor. Cross-age teaching was advocated as a way to increase the tutor's knowledge and to stimulate a career in teaching. Literature within the cultural transmission model expanded in the 1960's, but the results of these programs relied mostly on anecdote and sometimes on achievement test and attitude scale results.

Simultaneous with the increase in these programs were the beginnings of literature within the romantic ideology. According to this view education is the unfolding of the individual's natural (i.e. biological, intellectual, emotional, spiritual and ethical) self. The task of education was seen to be the removal of any societal obstacles from the child's path in order to provide the optimal environment for the discharge of innate positive and creative energy. The relationship between tutor and child was stressed above the learning of either. Here the trend moved away from didactic and restrictive

teaching methods (e. g. Lippitt, Giseman and Lippitt, 1969) to unstructured, inductive group processes (Rasmussen, 1969). Lack of specific definitions of concepts about generalized growth, however, led to frustration in validating results.

With the emergence of programs that conceptualized the effect of such teaching in terms of empirical research on psychological development, the progressive ideology emerged. Here the task of education was to stimulate development, defined as the attainment of higher states of cognition based on an invariant sequential pattern. Knowledge results in a change in the individuals structure of thinking often as a result of conflict and conflict resolution. This framework surfaced, at least in part, as a result of the search for a methodology and psychological considerations superseded practical necessity.

Of the three ideologies progressivism supports the newest and sparsest literature in this field. However, perhaps the most remarkable feature of these studies is the variety of participants, goals and procedures that they have employed. They have varied widely in the age difference between tutor and tutee, ranging from adults tutoring kindergarteners to same-age and same-grade pairings. Goals have ranged from the structured and programmed tutoring projects concerned with tutee's reading achievement to the inner-city project's emphasis on social and academic achievement. Only a few broad generalizations can be made based on the existing literature. Rather than identifying critical issues and problems based upon theoretical considerations, most studies to date have been designed only to determine if the particular tutoring situation employed is efficacious. Devin-Steehan, Feldman and Allen (1976) summing up the situation have called for empirical research on this issue to :

> "rest upon a firm theoretical foundation. All too often hypotheses have apparently been formulated in an ad hoc fashion, with little regard for conceptualizing the problem in theoretical terms. Unless investigators in this area make a stronger attempt to draw more directly upon the mainstream of psycho-

> logical and educational theory, it is likely that tutoring research will continue to be rather fragmented, inconclusive, and noncumulative".
>
> (p. 380).

Clearly it is important to refine experiments of this nature to determine if this method of instruction can be recommended regardless of the material to be taught, and of the pre-existing knowledge of the children. The question arises, however, whether it is necessary to attribute such specific roles as 'tutor' and 'pupil' to children (i. e. to transpose the classic teaching relationship) or whether it may be sufficient to create more symmetrical and co-operative peer group learning situations. In fact several educationalists have advocated the benefits of such peer groups, suggesting that in many instances the teacher's academic authority may be viewed as inhibiting many children's active reshaping of their existing knowledge. Holt (1965), for example, has suggested that within many schools, teachers frequently appear to children as dominant authority figures. He proposes that teachers may rate success too highly and depend on it too much resulting in children regarding failure as disgraceful. He suggests that many children develop a fear of failure which, if strong enough, may lead them to develop unexpected strategies which are self-protective and aimed above all else at avoiding trouble, embarrassment, disapproval or loss of status.

However, when the teacher distances himself from the social situation the usual source of authority is also removed and the control of learning strategies transfers to the pupil's hands. Barnes (1976) observed that organizing children into small groups produced a new communication system which was progressively shaped by the children in the course of their discussions. He suggested that these situations were more likely to be responsive to the learner's sense of what was needed, what they already knew, to their interpretation of the tasks given, and to their intuitions about what constituted useful

ways of tackling those tasks. He argued that it is the responsiveness to the learner's view of what is required that makes the study of peer groups so informative. However, once again many of these views were derived from anecdotal observation and little systematic evidence was obtained to support them.

It is the task of educationalists and psychologists alike to find out what conditions must be met and what processes must be brought about for educational inventions of this nature to be productive. In respect of attempts to disentangle the critical variables from the many inessential ones, in order to understand any changes in behaviour and achievement observed, research of the kind presented in this thesis could be highly valuable. It is evident that there are many potential benefits to be reaped from the wider adoption of peer groups as a learning situation within schools. This is not to propose that teachers should never present facts to pupils directly. There will always be information to be presented and established procedures to take pupils through. Nor am I recommending the use of small groups as a universal panacea, only that pupils should as often as pos sible be engaged in the formulation of knowledge and one productive way in which this can occur is in small groups. Even then it appears that in the most productive situations children should not be left totally unaided to construct the knowledge they need. While my research suggests the potential of child-child situations for learning, it also suggests that any benefits will be partly dependent upon the nature of the tasks, the participants and the management of the situation by the teacher. The role of the teacher will be particularly important in relation to the manner in which he structures and directs the situation and how he presents the problem.

In the future it is hoped to make a start on bringing recent psychological research on peer interaction to bear on the practical issues of group work in the classroom. Studies of the role of experience of conflicting viewpoints in cognitive growth ought to carry implications for the optimal management of group learning in schools. The full implications of this research for education are yet to be realised.

Perret-Clermont has reported findings suggesting that under-privileged subjects may reap particular benefits from working with their peers (Perret-Clermont, 1980 ; and Perret-Clermont and Schubauer-Leoni, 1981). These and other findings in this area may provide important information for the creation of new and productive learning situations in our schools. However, the theoretical concerns motivating the psychological work to date, have militated against such application, since the tasks used and the interaction conditions studied have typically been highly contrived and remote from the concerns of the teacher. To exploit its full value the research needs now to be extended in a more pragmatic fashion. It is necessary to develop understanding of the conditions (both in terms of tasks and in terms of groups) which govern the productivity of an interaction, and about the indicators which could be used to monitor the effectiveness of a group. It is to be hoped that work of this nature will be carried out in the near future and some of these difficulties resolved.

7.6 FUTURE RESEARCH

The research presented in this thesis has suggested two further issues which could fairly readily be resolved using a slight modification of the present paradigm. The two issues needing clarification concern the role of verbally expressed conflict in evoking individual progress, and the effect of age on the facilitation of learning through interaction.

Findings arising from the investigation of peer interaction using the Logic 5 task led to the observation that aspects of verbal interaction (e.g. verbal countering of a partner's judgement) were highly predictive of post-test performance. This finding, however, remains ambiguous since there was not an independent measure of the children's initial levels of ability on this task : it may be that more able children argue more, or it may be that children who argue more make greater progress. The Logic 5 task did not make individual pre-testing easy for two reasons. Firstly, it was difficult to introduce the task and to assess performance on it at the same time. Secondly, the

digit sequences selected were outside my control, and since for various reasons some were more difficult than others, a lot of 'noise' was involved. These difficulties could be resolved by moving to a programmable device, such as a PET microcomputer. The problems could then be overcome by introducing the task in relation to two digit sequences and then pretesting in relation to three digit sequences. The sequences could be fixed ensuring comparability between subjects.

The second issue relates to the question of the age of the subjects. In accordance with Piaget's early suggestions concerning the role of peer interaction in breaking down egocentric throught most experimental studies of peer interaction have employed Piagetian concrete operational tasks. As a result these have all generally been concerned with the same age range of subjects. One consequence of this is that most evidence of the facilitative effect of peer interaction on individual understanding relates to a specific age range. In Chapter 6 I presented some preliminary evidence which suggests that similar effects may operate over a wider developmental period. These findings indicated that children aged 12-13 years can also benefit from social interactions with their peers. Unfortunately no similar evidence was found to support this process in 5-6 year old subjects. It was argued that this was due to the task involved being too complex. My research has shown that subjects need to havebegun to adopt systematic strategies before interaction will be effective. But also if the task is so straightforward that all adopt the correct strategy, social exchanges about the problem cannot be expected to have much effect. It will have its effect precisely in the resolution of conflicting strategies. If this is the case then it seems likely that interaction will be facilitative of learning in adults and young children, provided that the task lends itself to structured interaction and is of a suitable level of difficulty. A demonstration of this could be attempted for adults, as well as for younger children than have generally been studied, using the 'micromastermind' task suggested for the previous investigation which could be made more or less difficult (without changing its essential nature) simply by varying the length of the target digit sequence.

Other issues which may be investigated in the future and which may be influential in determining the outcome of an interaction between peers may include the personal characteristics of the interactants. Some of the factors that may prove interesting are whether the dyads are of the same sex or opposite sex, and whether racial or socio-economic factors along with the status the individuals' hold within their peer group are influential. D. Mackie (1980) has already reported evidence of cultural differences in response to the kind of social conflict individuals experience. These characteristics may be central to such issues as whether or not one member of a group will dominate an interaction. Furthermore, it would be interesting to investigate whether frequent involvement in group work or co-operative experiences of the kind described throughout this research, not only have benefits from an intellectual standpoint but from a consideration of social development also. It may be that a child's social understanding along with his moral and emotional development will be effected when he engages in tasks requiring him to consider the position of others as well as his own viewpoint. These situations can clearly be seen in terms of role taking, involving the development of one's ability to understand the perspectives of others and the development of role taking ability has in fact already been suggested as an important aspect in the growth of moral judgement (e.g. Selman 1971).

As was previously pointed out, there is a need for more applied research in this area to consider and develop the educational potential of this work. Clearly there are difficulties in moving from relatively pure research where the problem is chosen to suit the experimenter to the practical issues of everyday education. Progress in this area may be aided by a closer working liaison with teachers who have practical knowledge of the problems of technical, material and temporal organization involved with dealing with a class of young children. This work may be concerned with the difficulties of setting up several well organized groups in a classroom as well as with the problem of monitoring and assessing their performance relative to other teaching situations. Practical limitations may result in the need to consider children in larger groups than a dyad which may, in turn, suggest a whole new range of problems. In the long-term understanding

of these issues may have strong implications for school curriculum and the way in which it shapes the understanding, beliefs and values of children.

The obvious task dependence of any detailed analysis of peer interaction situations present both a difficulty and a challenge to the researcher. If this field of study is to be productive either of new insights into the process of development or of findings of educational value, some kind of typology will be needed for types of interaction and for types of task. A framework is needed which will both describe and enable prediction of the consequences of particular types of interaction in relation to particular types of task. It is to be hoped that researchers engaged on this problem will formulate research problems of greater sophistication and significance, and thereby contribute to the solution of the numerous theoretical and practical problems encountered in this area of study.

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