UNIVERSITY OF SOUTHAMPTON

THE ROLE OF LANGUAGE IN COGNITIVE DEVELOPMENT: SPEECH AND SERIATION IN CHILDREN OF 5-6 YEARS

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ABSTRACT

FACULTY OF SOCIAL SCIENCES

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THE ROLE OF LANGUAGE IN COGNITIVE DEVELOPMENT: SPEECH AND SERIATION IN CHILDREN OF 5-6 YEARS

by Margery Heber

Among explanations of the relation of language to cognitive development Bruner (1964) and Piaget (1970a) provide a contrast. Bruner has held language to be the major instrument of external influences moulding thought, while Piaget views it as merely one medium which represents developing thought systems. The first study of the present work is based on the language training experiment in seriation of Sinclair-de-Zwart (1967). Two groups of children comparable in seriation but who were initially at different levels of competence in the appropriate use of the relevant descriptions were trained in this use and then compared for subsequent progress in seriation. Significant progress followed for experimental subjects which was notably more rapid among those with prior command of the descriptions. Results taken together suggested an interactive process uniting speech-in-context with cognition.

Four more similar studies were undertaken with subjects most likely to respond promptly to intervention in order to explore the nature of this interaction. A comparison of different problem situations revealed that dialogue between the observer and child was more effective than learned descriptions or action without relevant discourse. Yet discussion between child pairs of equal cognitive status was not effective. Further analysis showed that the influence of dialogue operates where the child is led to explain and justify the central relations of a problem. It is not the terminology he uses but the generality of his explanation which influences progress in understanding. These findings are discussed in terms of a synthesis of views of Austin (1962), Bruner (1973, 1975), Polanyi (1962) and Piaget (1977). Speech used in communcation between the child and another more experienced person becomes an heuristic for resolving a problem by negotiation. This promotes cognitive growth.

PREFACE AND ACKNOWLEDGEMENTS

In a previous investigation (Heber, 1974) the author found significant differences in the kinds of questions asked by two groups of seven year old boys (middle class, MC and lower working class, LWC). Although their reading ages were comparable and the two groups of children asked as many questions as each other, the MC group used more complex questions which seemed to be related to more integrated conceptual exploration than did the LWC group. The way that the middle class children were using questions seemed more likely to advance their knowledge and understanding than the way the lower working class children used them. Indeed the complexity and conceptual content of the questions asked by the middle class children suggested that their cognitive grasp was already in advance of their lower working class peers. These findings raised the issue of the role that language may play in cognitive development. The present dissertation is the result of following up that problem.

In the early 1970s the controversy was typically couched in terms as concerning the 'role of language in cognitive development'. This amorphous idea had to be narrowed if it was to be addressed empirically. Similarly at that time the theoretical argument directly relating to the problem was relatively restricted and simple. Subsequent analysis and empirical findings draw upon a much wider field. The thesis follows this pattern first in attempting to elucidate the contention between Piaget and Bruner in the matter, then as other features of speech influence emerge other theorists are referred to. This finally leads to the suggestion of a synthesis of independent theoretical accounts in explanation of present results.

The initial stages of the work on this project were carried out while the author was in receipt of a grant from the SSRC. Study 1 which is the starting point of this research was done under this aegis (Heber, 1975:1977). The remaining work was undertaken independently but with substantial encouragement and material support from the Department of Psychology of the University of Southampton under the direction of Professor Gordon Trasler. I am most grateful for the assistance of the SSRC and particularly to Professor Trasler who first introduced me to members of the Department under whose guidance the study of questions was carried out. Professor Trasler has continued to give encouragement and practical assistance. Without

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The children of the schools provided the subject matter of the thesis. It is hoped that their enjoyment is recompense for the major part they have played. The staff of the schools have given me liberal hospitality and free entrance to their classes at all times. The First Schools and teachers concerned are: Miss E. F. Miller and staff at Mansell, Miss E. M. Neck, Mrs. T. Woodward and staff at Highfield, Miss M. M. Jarvis and staff at Hollybrook and Mrs. S. Stephens and staff at Hardmoor. Permission to use the schools was kindly granted by the Local Education Authority.

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Chapter 1

SPEECH AND COGNITION: THE NATURE OF THE PROBLEM

CONTRASTING VIEWS

> OBS. 125. At 6;7 (4) J. was looking for her doll and could not find it: "You've no idea where you put it? -- No, I've no more ideas in my tummy. My mouth will have to give me a new idea. -- Why your mouth? -- Yes, it's my mouth that gives me ideas. -- How? -- It's when I talk, my mouth helps me to think." (Piaget, 1962, p.256).

These ideas coming from a child of Piaget's appear to express an opposite view to that of her father regarding the role of speech in thinking. Yet her opinion is not confined to childish theory. In more sophisticated guise it is the viewpoint of many who disagree with Piaget. The present project is a study of the role of speech in cognitive development and begins by considering the controversy between Bruner (1964), Bruner et al. (1966) and Piaget (Inhelder and Piaget, 1964) followed up by Sinclair-de-Zwart (1967). Bruner et al.'s account (1966) suggested that once the child has mastered speech this then becomes the major instrument of environmental and social influences shaping thought. Piaget states an apparently opposing view. He believes that the origin of logico-mathematical ideas resides not in language but in the child's earliest activities. Each successive system of actions represents an increasing complexity of relations which gradually coalesce into logico-mathematical groups (Piaget, 1962, 1970a; Inhelder and Piaget, 1964). In some recent accounts (Piaget 1970a, 1970b) Piaget appears almost to dispense with external social influences and the speech which mediates them in favour of the child's own cognitive constructions. This sketch of contrasting viewpoints indicates how on the one hand speech has been regarded as the mould of developing thought, and on the other hand thinking has been considered to be constructed in some other way, in which case speech is merely its vehicle. Although this account does oversimplify the theories of Bruner and Piaget the problem has traditionally been interpreted as a choice between these simplistic extremes. Moreover one can underestimate the influence of such interpretations. In fact the impact of this crude dichotomy can be seen in education (see, for example, Bereiter and Englemann, 1966; Furth, 1966).

What justification is there, however, for suggesting that one or other viewpoint in clear and simple form is too simplistic? The

answer seems to be that they overlook the changing complexities of cognitive and linguistic development and the interactions between them which must similarly change at different periods of development and in different contexts. The term language covers many forms of expression, written and spoken. Similarly cognitive development is manifested in various ways of operating such as remembering and problem solving. These can be detected by appropriate tasks but they cannot all the determined by the same task and bundled together under the terms 'thinking' or 'cognition'. But it is reasoning as demonstrated in problem solving which seems central in cognitive development. This suggests that one way to tackle this problem is to choose a period when speech is well advanced in the child. Then the speech should be applied in relation to a task which is appropriate to 'logical' thinking i.e. one which demands new reasoning of the child; which goes beyond immediate perceptual evidence. The influence of the specific description upon the development of new understanding of a specific problem may then be assessed.

The nature of the problem

This complex problem is difficult to resolve not only from its complexity but because the issue is fundamentally epistemological; one is asking how knowledge evolves but in so doing one cannot avoid assuming some form of paradigm as the basis for empirical study. The main concern is that the initial presuppositions should be explicit and internally consistent. The problem should be analysed fully. Then having chosen the most likely point of attack to be empirically useful, results should have some limited yet clear value.

The problem expressed as 'the role of language in cognitive development' is too amorphous to be addressed empirically. Speech, which always occurs in some relevant context is the form of linguistic expression which may first begin to affect a young child's growing understanding and its influence upon the development of some central area of reasoning should be investigated. This approach centres on the relation of speech to cognitive development. Studies of the acquisition of speech and cognition independently of each other cannot provide precise information about their mutual interaction in regard to particular aspects of development although it is important to be aware of these. For instance one must decide the nature of cognitive growth from extant studies. Similarly the nature of the child's

speech; what language is doing for him and thus what aspect of it should be studied. It is not possible in prospect to determine the best solutions otherwise an empirical study would be unnecessary. But the point being made is that questions have to be begged in terms of current knowledge and that one should be aware of them.

VIEWS ON THE NATURE OF LANGUAGE AND THOUGHT AND THEIR INTERRELATIONSHIP:

It would be impracticable to review all theories relating to language and thought, to their development and to their mutual influence. But it may be useful to indicate some of the ideas which relate to those of Piaget and Bruner respectively.

Piaget's extensively replicated work suggests that conceptual organization may be seen as a superordinate system of structures which continually changes as the individual adapts to new experience (cf. Piaget, 1971b). Many other thinkers concur in some such idea. Indeed at the turn of the century, Galton and Freud, independently, indicated reasons for supposing complex and indeterminate depths of thought (cf. Reeves, 1965). Although Bruner has not developed an explicit and definitive outline of the nature of thought it is clear that he believes it to be complex both in the processes by which it develops and in its structure (cf. Bruner et al. 1966).

Clearly the construction of language is complex but here its relationship to thought is the issue to be considered. In terms of the present controversy it may be seen in two ways: either it is a formal system of signs with socially agreed meanings which are learned and then applied by the child as he is directed to do so; or, instead the systems of signs represent networks of <u>possibly</u> agreed meanings which are in constant flux according to their communicative uses. De Saussure (1960, 1973, 1967-74) was thought to have originated the idea of language as a formal system and it is true that he contrasted La Langue (the formal system) from La Parole (its spoken production). But Culler (1976) has reappraised Saussure's views from a comparison of all his unpublished notes. From this one gains a new perspective which indicates that Saussure's idea of language was much closer to the second alternative quoted above than the first. For him the formal system was only something to hang currently negotiated meanings upon. Interpretations are flexible:

> This means that one should not think as logocentrism would like to, of the presence in consciousness of a single autonomous signified. What is present is a network of differences .... the whole notion of a linguistic system, the whole notion of la langue as Saussure defines it, is that of networks of differences at the level of both signifier and signified .... The act of uttering is simply a transitory and hence imperfect way of using one network of differences (those of the signifier) to produce a form which can be interpreted in terms of the other network (those of the signified). (Culler, 1976 pp. 111-112).

According to Culler the 18th Century linguists did not differentiate words from the concepts they represented but in contrast de Saussure provided a subtle account of the way words enable meanings to be developed in communication. Piaget did not have recourse to Saussure's notes so that he regards the work of de Saussure as mainly effecting early structuralism in linguistics and having affinities to the logical postivist view:

> While the logical positivists enthusiastically followed by Bloomfield, wanted to reduce mathematics and logic to linguistics and the entire life of the mind to speech, Chomsky and his followers base grammar on logic and language on the life of reason. (Piaget, 1971b, p.83).

One may see from this quotation that Piaget deplores the idea that thinking of any kind is speech. What he does derive from Saussure is the idea that language, spoken or written, is only one aspect of semiotic processes. This rich assumption draws him away from ascribing much importance to the formal social sign system of language in the development of thought. What Piaget wants is a creative notion of language and although he disagrees with Chomsky's a-priorism he finds himself in tune with his views on the nature of language:

> This genuinely structuralist procedure of devising a coherent system of transformations (in effect more or less complex "networks") is not only an excellent instrument for comparative study but possesses the additional interest of applying to "individual competence" (being the internalized grammar of the speaker-hearer) as well as to language as a social institution. (Piaget, 1971b, p.85).

Piaget's conception of cognitive growth as pre-eminently self-regulating; and cognition as an organismic system which is constantly being created and re-created by the individual from his own experience is in tune with Chomsky's notion of language. This system of transformations can be incorporated into Piaget's theory of

thought with only minor modifications. Above all it is an instrument of individual competence and not primarily the shaping tool of a social institution.

Bruner's views (1964, and Bruner et al. 1966) on the nature of language are in line with those of Vygotsky (1962). Language is simply a social sign-system. Although thought and speech develop independently of each other at first in the child, once the latter is in the child's repertoire it becomes for him a major tool of thought. This sounds all too easy but Vygotsky does not subscribe to straight forward sign-referent match of thought and word. Both evolve together during development:

> Thought and word are not cut from one pattern .... The structure of speech does not simply mirror the structure of thought; that is why words cannot be put on by thought like ready-made garments. Thought undergoes many changes as it turns into speech. It does not merely find expression in speech; it finds its reality and form. (Vygotsky, 1962, p.126).

Having intimated this subtle constructive influence Vygotsky is perfectly clear that he thinks that speech precedes and shapes thought. He claims that the child 'masters the syntax of speech before syntax of thought'. (ibid. p.46). He leads up to the claim that:

> Thought development is determined by language, i.e. by the linguistic tools of thought and by the sociocultural experience of the child.... The child's intellectual growth is contingent on his mastering the social means of thought, that is, language .... The nature of the development itself changes, from the biological to sociohistorical. Verbal thought is not an innate, natural form of behaviour but it is determined by a historical-cultural process and has specific properties and laws that cannot be found in the natural forms of thought and speech. (ibid. p.51).

Bruner is greatly attracted to Vygotsky's ideas. He develops them himself in his paper 'The Course of Cognitive Growth' (1964). The subtleties of child adaptation to language use in the expression of meaning indicated in the first quotation from Vygotsky seems to be overlooked by Bruner but language as a social instrument which shapes thought is expounded in Bruner's own way. This will be described shortly but neither Vygotsky nor Bruner satisfy Piaget. The fundamental reason being epistemological. For Piaget, one cannot at one and the same time believe in thought as a complex self-regulating system and also think its major construction derives

from some formal extrinsic 'template'.

SPEECH AND COGNITION: FURTHER DEVELOPMENT OF THEORIES OF THEIR RELATIONSHIP

At this point the contrasting views of Piaget and Bruner in relation to language and thought will be elaborated. On the whole other theories except as they relate directly to those of Piaget and Bruner will not be considered here but the theoretical context will be broadened as an outcome of the findings later in this dissertation.

Bruner's 1964 paper 'The Course of Cognitive Growth' first led Sinclair-de-Zwart (1967) to make her studies of language and thought. Although Bruner did not explicitly criticise the Genevan approach in his paper the point of view he took as a result of his experimental studies was in total contrast to Piaget's theory of the role of language in cognitive development. Apparently inspired by Vygotsky (1962) he develops an interesting and plausible thesis. He says that human development is 'alloplastic' rather than 'autoplastic' by which he seems to mean that through the millenia human social systems have evolved which extend and 'amplify' individual capacities. There are three kinds of social implementation: those that extend motor capacities such as tools; those that develop sensory capabilities such as smoke signalling or radar; and those that promote man's reasoning powers such as language systems. Like Vygotsky he is suggesting that man enters into his 'historico-social' inheritance through the medium of language and like Vygotsky he seems to equate verbal thought with rational thought. Bruner thinks that the earlier forms of thinking and their representation by enactive and iconic modes are supplanted by language, the symbolic medium, for purposes of rational thought but these earlier forms continue to be available to the individual. He considers all these forms of representation, not as static models, but as socially formulated procedures which enable the individual to process and select his experience. They provide a framework for the development of thought:

> We know and respond to recurrent regularities in our environment by skilled and patterned acts, by spatioqualitative imagery and selective perceptual organization, and through

> linguistic encoding which, as so many writers have remarked, places a selective lattice between us and the physical environment. (Bruner, 1964 p.2).

For Piaget there is an insoluble paradox in this account of the matter as also with that of Vygotsky for unless they see cognitive development as an additive linear process there seems to be no way of accounting for the extrinsic patterning which Bruner and Vygotsky suggest is the case. If language as a formal social sign-system serves to frame and shape thought then cognitive growth becomes just a matter of the acquisition of social know-how and physical environmental patterning. This empiricist view of thought Piaget does not believe is consistent with Bruner's account of thinking nor does it tally with his own. He therefore cannot give credence to the major role Bruner attributes to language in the growth of thought. Piaget takes an interactionist view. It is just because he believes that cognitive growth is self-directed and evolving that social and physical environmental influences, essential as they are, are incorporated as and when individual growth requires in terms of its inner equilibrium. Language cannot be regarded as a grid or lattice; it can only be a subsidiary tool to the processes of assimilation and accommodation. This view leads Piaget to make very little of conventional social pressures transmitted by language outside the individual's own constructive growth. He therefore adopts Saussure's idea of semiotic processes of various kinds. These are imagery, play and language (Piaget, 1962; Piaget and Inhelder, 1969). These processes the child uses to develop for himself his own systems of understanding. But these systems evolve primarily from his own activities and not from the way he utilises semiotic representations. However Piaget does not dismiss the role that language may play towards assisting the hypothetico-deductive thinking which emerges in adolescence and which is characteristic of the most disciplined forms of adult thought. It remains to ask when and how this influence really begins. Since generalised and formal systems of ideas are emerging in children between 5 and 7 years, systems such as classification, ordination and conservation, how does the symbolic system of language affect this development if at all?

But neither Piaget nor Bruner provide sufficiently specific explanations to account for the reciprocal influence of speech and cognition although they do concede that it may alter at different

stages of development. Bruner sketches the biosocial history of mankind into which he neatly fits his account of cognitive development. This is a tenuous interpretation of his empirical data. It is speculative to say the least to argue from the broad canvas of phylogeny to specific experimental outcomes at particular ontogenetic points in time. The phylogenetic data are of a different order of reliability and validity than the data of present experiments. Mankind's social development is open to a variety of interpretations and even if these are broadly accurate it is doubtful whether in detail they can be made to tally with particular developmental findings. The gaps in Bruner's thesis must remain speculative. Piaget's logical model can be filled out in theory by empirical study but only gradually can such detail be accomplished.

Here further details will now be given of the empirical data used by Bruner and Piaget respectively in support of their claims for the role of speech in cognitive development. Since Bruner used Piaget-type tests as the basis for his experiments and since the present work is based on that of Sinclair-de-Zwart in the development of seriation it will be necessary to justify the use of these tests in the light of current criticism of Piaget's idea. This will be undertaken at the end of the chapter. Chapter 2 will give an account of the first empirical study of the present project which followed up the work of Sinclair-de-Zwart (1967) on the influence of speech on the development of seriation.

To consider Bruner's approach in more detail one must appreciate his strong predeliction for the force of the social and educational influence of language which has a common-sense ring about it mainly based on correlative evidence:

> The persistently rational quality of behaviour .... enters the picture when there is internalization of symbolic techniques - language in its natural form, and then artificial languages of number and logic. (Bruner, 1966 pp.18-19).

Bruner tackles the problem of the influence of language on cognitive development in a general way and on a purely psychological plane. He appreciates for instance, that both Vygotsky and George Herbert Mead imply that there is a special power in dialogue as opposed to other speech modes but he does not specifically explore this influence. His conclusions are:

> Once a child has succeeded in internalizing language as a cognitive instrument, it becomes possible for him to represent and systematically transform the regularities of experience with far greater flexibility and power than before. (ibid. p.4).

Bruner acknowledges the influence of Vygotsky (1962) and Luria (1961) in this account.

Bruner (1964; Bruner et al. 1966) bases these conclusions on a series of experiments, using as subjects children between the ages of 4 and 7 years who are at the period of transition to operational thinking according to Piaget's scheme of cognitive development. In some cases 9 and 10 year olds are also compared. The problems they are given are for the most part derived from Piaget and the way that they solve, describe and justify these are considered. Prior to being given these problems the children are selected as preoperational at pre-test, then the ensuing problems are set and the children are subsequently post-tested. Some of the most interesting findings concern the response to intervention tasks. For instance Bruner and Kenny (Bruner, 1964) asked children of different ages to replicate a 3 by 3 matrix of flasks, seriated by height in one plane and by diameter in the other. The flasks were scrambled after they had been inspected and described by the child. He was then asked to reconstitute the array as before after one glass had been placed correctly by the experimenter. Exact replication of the matrix posed the children no difficulties but when they were required to produce an arrangement which was spatially transposed, the smallest item being at the opposite pole of the grid and vice versa, only the 7 year old children succeeded. Bruner felt that this success tallied with the children's descriptive competence. These older children talked their problem out, besides which their descriptions were apposite whereas those of the younger children were not. The 7 year olds used 'dimensional' terms, e.g. 'that one is higher, that one is shorter'. The 6 year olds used 'global' descriptions, e.g. 'that one is bigger and that one is little', and the least efficient children of 4 and 5 years old described differences as, 'that one is tall and that one is little'. When all ages were pooled children with poorer descriptions were overall less efficient in the task. This correlative evidence suggests to Bruner a linguistic influence on cognition but he realises that the point must be pursued further. The experiment undertaken by Francoise Frank (Bruner, 1964; Bruner et al. 1966) is thought to tighten the argument considerably. She compared

children of age groups between 4 to 7 years. The children were initially non-conservers of liquid quantity and this task was used for intervention with a screening procedure in order to isolate the effect of verbal description from the perceptual appearance of water levels. First one obtains an equality judgement for two equal amounts of water contained in similar flasks. A wider beaker of the same height is placed adjacent to them. A screen is interposed and water from one of the two flasks is poured into the third while the child is asked to predict the amount of water that it will contain. When the screen hides the water level from the child there is an increase in conservation judgements at all ages. When the screen is later removed and the test repeated 4 year olds revert to nonconserving judgements but older children tend not to do so. Post-testing a few hours later shows that 5 year olds upwards on the whole retain their notion of conservation in face of perceptually conflicting evidence. Bruner argues from this and other experiments:

> It is plain that if a child is to succeed in the conservation task, he must have some internalized verbal formula that shields him from the overpowering appearance of the visual displays .... ' (Bruner, 1964, p.7).

This certainly seems to be true but it is also clear that spoken instigation is only effective among children who already show signs of understanding conservation. If Bruner is trying to imply that language is instrumental in cognitive construction then this point rather weakens his case. He does not mention it. But he is careful to point out that his main aim is to study the processes of cognitive growth and in another similar experiment carried out by Sonstroem (1966) it is clear that only non-conserving children were selected. This experiment concerned conservation of continuous quantity using clay. The procedure was as in all previous studies a pre- and post-test design interleaved by different forms of intervention. Sonstroem had 81 subjects of evenly distributed ages and sexes divided into 8 groups. Interventions consisted in varying combinations of manipulation, labelling and screening of the clay. For the screened condition the child watched one or other piece of clay being moulded to a new shape by the experimenter but only made his judgements of amount when both were hidden from his view. Naturally all the conditions required the children to answer questions about the amount of clay in each piece before and after it had been

altered in shape but the labelling condition expanded the descriptions of the dimensions of width and height or length. In the manipulation condition the child moulded the clay but in all the others he only watched the experimenter doing so. The best post-test results occurred in subjects who had manipulation combined with labelling. Bruner says of 'manipulation' and 'labelling':

> each of these worked only when the other was also present. Thus manipulation without labeling was virtually ineffective, and the same was true of labeling without manipulation; but together they produced a remarkably high degree of learning among children. (Bruner et al. 1966, p.221).

These findings give Bruner grounds to dismiss Piaget's stress on action as the processing force behind the acquisition of the understanding of conservation. He says:

> What our experiment did precisely, by the use of manipulation and labeling, was to offer the child ways of representing the conservation problem that conflicted with the ikonic. By offering him manipulation, we were encouraging enactive representation; and by offering him verbal labels for compensating attributes, we were encouraging symbolic representation. In short, he was made to cognize the clay "physically" and verbally, instead of perceptually. (ibid. p.223).

What Bruner does not consider is that the child's search for understanding through action was also occurring in dialogue. Perhaps 'labelling' is an altogether too static notion to explain the interaction taking place. Bruner (1964) also quotes the experiments of Olver (1961) and Rigney (1962) to indicate the parallel between language construction and children's ways of classifying. Children were asked to sort objects or words into groups. There was an obvious shift from the younger to older children in the manner of grouping; from the perceptual and functional to the complexive or superordinate. This implies a linguistic influence upon cognition for Bruner:

> As language becomes more internalized, more guiding as a set of rules for organizing events, there is a shift from the associative principles that operate in classical perceptual organization to the increasingly abstract rules for grouping events by the principles of inclusion, exclusion, and overlap, the basic characteristics of any heirarchical system. (ibid. p.11).

Interestingly Sinclair-de-Zwart (1967) relies on similar parallels to support the opposite point of view, namely that cognition is

reflected in the child's syntax, not that linguistic rules govern his thought! Only the experiments of Frank and Sonstroem give more than a loose suggestion of the constructive power of language which Bruner is suggesting. Bruner appears to be arguing that there is a syntactical influence of language upon cognition. This seems feasible because cognition to him is envisaged as a kind of two-dimensional information processing skill. It starts with the formation of identities and awareness of differences and gradually builds up into complex heirarchical systems. Conceptual organization of environmental input can only be achieved by a highly selective yet inclusive coding scheme such as language. But Piaget thinks that if thought is complex and heirarchically organized its formation must be too subtle to be accounted for merely by the accretion of information and the syntax of language is insufficient to explain its development, particularly because this implies an extrinsic moulding influence incompatible with the process of self-regulation by which Piaget and his followers believe that thought is evolved.

How does Piaget's theory compare in detail with that of Bruner and what evidence is cited in its support? Piaget is nowadays quite uncompromising about the origins of thought. He dismisses empiricist views thus:

> In the common view, the external world is entirely separate from the subject, although it encloses the subject's own body. Any objective knowledge, then, appears to be simply the results of a set of perceptive recordings, motor associations, verbal descriptions, and the like, which all participate in producing a sort of figurative copy .... of objects and the connections between them. The only function of intelligence is systematically to file, correct etc., these various sorts of information .... In such an empiricist prospect, the content of intelligence comes from outside, and the coordinations that organize it are only the consequences of language and symbolic instruments. (Piaget, 1970a, p.703).

This account broadly fits Bruner's theory which has just been outlined. In contrast Piaget states his own conclusion:

> But this passive interpretation of the act of knowledge is in fact contradicted at all levels of development and particularly, at the sensorimotor and prelinguistic levels of cognitive adaptation and intelligence. Actually in order to know objects, the subject must act upon them, and therefore transform them: he must displace, connect, combine, take apart and reassemble. (ibid. p.704).

He goes on to claim that the most elementary actions such as pushing and pulling are linked generically with what he calls interiorized actions, 'carried out mentally' (ibid. p.704). These constructive actions which are part of the mental constitution of the individual are 'operations'. They effect 'transformations' which constitute knowledge. This is an entirely different and more dynamic conception of 'knowledge' than that of Bruner. According to Piaget there is no predetermined relationship between subject and object. This varies according to the selective needs of the individual's self-regulative functions. In order to be consistent with this idea language as a formal sign-system of society only plays a secondary role in cognitive construction. Piaget carries the argument through to all levels of intellectual development. Only grudgingly does he admit the possible power of language for the development of concrete operational thought although he must concede its importance in formal thinking. He says:

> Turning to the question of the relations between language and logical operations, we have always maintained that the origin of logical operations is both deeper than and genetically prior to language; that is, it lies in the laws of general coordinations of action, which control activities including language itself. (ibid. p.722).

Language is only part of the transition to operational thinking in which the semiotic functions as a whole play some part and 'it is certainly imitation in the general sense which constitutes the transition between sensorimotor and semiotic functions'. (ibid. p.722). Although Piaget accedes that there is a difference between the question of origin and manner of development at later stages:

> But there still remains to establish more precisely the relations between language and the logical operations on the level of interiorized thought. (ibid. p.722)

he is certainly predisposed to assume that they are consistent with each other. Thus he easily cites the findings of Sinclair-de-Zwart (1967) to support the idea that language does not fashion the emerging logic of the child at 6 or 7 years:

> These data ... indicate that language does not constitute the source of logic but is on the contrary strutured by it. (Piaget and Inhelder, 1969, p.90).

He quotes Sinclair-de-Zwart's findings as evidence for his view in a variety of publications (Piaget and Inhelder, 1969; Piaget, 1970a; Piaget, 1970b; and Piaget, 1971b). But he concedes that language may become 'an instrument in the service of intelligence' (Piaget, 1970a, p.722). This admission comes back to the point that the origin of cognition may not follow the same process as the particular interaction of speech and cognitive advance at any specific point in development. At some stage new constructions of thought, formulated by speech may occur. Piaget perhaps too easily dismisses the formulating power of speech even when classifications, seriation and conservations are being grasped by children between the ages of 5 and 7. Piaget relies mainly upon the findings of Sinclair-de-Zwart for empirical evidence. But consideration of her experiments shows that her findings are not conclusive. For this reason they will be appraised in detail in the next chapter. Other evidence which Piaget draws upon comes from Oléron (1957), Furth (1966) and Hatwell (1966). Oléron and Furth studied the intellectual development of deaf children and neither of them was able to show that these subjects did not suffer considerable intellectual deficit although Furth tried to produce arguments to minimise this. He gave his deaf subjects a considerable variety of tasks to some of which they responded reasonably well in comparison to children having no sensory deficit. However he had to admit that the deaf were least adept at problem solving which requires innovation. This he attributes not to their actual lack of linguistic ability but to their isolation from the 'living language' (1966, p.9) whose prime function is communication. Deaf children 'lack normal environmental stimulation towards an intellectual attitude' (ibid. p.152). It is not so much linguistic but environmental handicap that they suffer and this results in 'inability to look for reasons, not inability to reason' (ibid. p.152). However this does not mitigate their difficulties which are surely to do with a central cognitive function nor does it dismiss the role of language as contributing to it. The communicative function of language may indeed be its most powerful constructive influence. Piaget's argument was that deaf children who lack language do not have as much cognitive handicap as those who are blind yet who do possess the ability to speak. As mentioned above data concerning the deaf he drew from Oléron and Furth and the study of blind children to

which he refers is that of Yvette Hatwell (1966). Piaget's (1970b, p.46) reliance on evidence derived from handicapped subjects is unfortunate. It is to say the least unlikely that cognition will evolve in the same way for children having sensory deficits as for those who have not and even if blind children can speak their use of language may well be substantially different from that of sighted children. Moreover Piaget does not seem to have considered that Hatwell's subjects were not comparable. Their blindness was compounded with other handicaps in some cases, periods and degrees of blindness differed as also did length and type of schooling. Cromer (1974) has repeated work with blind children which shows them to be less retarded than Hatwell's results would imply.

Piaget's theory of the role of language in the development of thought is rooted in his studies of the way children's thinking develops. Because of his interpretation of this he regards epistemological arguments as basic. However he does draw on empirical evidence. That of Sinclair-de-Zwart (1967) he regards as a first essay but he quotes the results of her study extensively. Although evidence from handicapped subjects may only have indirect bearing on the processes of development in normal subjects he uses these studies as central to his case. Besides which, of the studies he quotes, that of Furth does not make sufficient distinction between types of tasks and their relative difficulty and that of Hatwell confounds blindness and other disabling influences. But Piaget's epistemology in itself suggests that speech cannot be a central influence in cognitive development.

Piaget's account of the development of thought leads from the actions of the infant to adult reasoning. The sensorimotor, concrete operational and formal levels of operation are three transition periods which change in quality. The first concerns immediate reactive and exploratory processes which are gradually transformed to a representational plane. Through experience increasingly complex systems develop which can operate with hindsight and foresight until in adolescence hypothetico-deductive reasoning is possible (cf. Piaget and Inhelder, 1969). Piaget's observations have led him to assume that one single process explains this long and complex development. This process consists in the individual's own operations. In infancy it is manifested as motor activity but it is later transformed onto a plane of semiotic functioning such as play,

imagery and delayed imitation. Out of this an idiosyncratic use of language evolves. This personal use of 'symbols' (as Piaget calls them) serves the child's own constructive activities. Only later does he acquire the conventional sign-system of the community. Thus in Piaget's scheme this last aspect of language is unlikely to be a major constructive influence in cognitive development until formal thinking begins. Accommodation is the aspect of cognitive processing by which the individual adjusts to his experience. Assimilation is the process of seeking experience. Piaget suggests (1962) that imitation is one of the earliest manifestations of accommodation. Before the child can speak he will use imitation as a means of reflection e.g. opening and closing his mouth in considering how to open a match box. Spoken utterances are at first not fully intentional indices such as the cry of pain. Symbols emerge as purely personal ways of featuring the child's ideas for instance when a match box is moved along to represent a car, or a cloth is cuddled as if it were a doll. Signs are the conventional uses of words which the child only acquires through his own system. For instance the word 'dog' will be associated with any animate creature to appear in the original context of hearing the word. Only gradually does the child fit it to the socially conventional associations. According to Piaget, signals, symbols and sign-systems are used by the child in that order as he grows in understanding. This terminology he derives from Saussure. It is more conventional to use the term symbol as the generic term and 'sign' for specific and idiosyncratic reference. Piaget believes that the child accommodates through imitative means but is at the same time constantly innovating. To do so he seeks out experience and experiments within his physical and social context. Speech is not constructing his thought systems but is deployed by the child for the purposes of adaptation. Through imitation, play and speech he can retain and unite elements of experience which he gradually conceptualises. Thus he eventually formulates systems of relations such as those of series and classes. From preconceptual thought he passes to an intuitive understanding of these sets of relations and eventually begins to grasp the elementary logic which characterises these kinds of systems. Thus from understanding broad differences between particular items placed in serial order he will gradually learn the specific relations which constitute any kind of ordinal series. All this development is conceived by Piaget to occur from the child's own construction; 'from

the inside-out and not the outside-in' to reverse Bruner's way of putting it. The child does not mirror the logic evolved by mankind although there is much that he will have to gain through education in predigested form. Real understanding only occurs when he has digested it into his own system. If Piaget is right he will do this best by making the experience and the language relating to it his own.

A POINT OF DEPARTURE: THE TRANSITION TO CONCRETE OPERATIONAL THINKING

For his empirical studies of the nature of cognitive growth Bruner chose the stage in development which in Piaget's scheme marks the transition to concrete operational thinking. By doing so he concedes that this is an important point of change in the child's cognitive development. Indeed common observation does seem to suggest that around 6 years children become more rational, more socially amenable and less unselfconscious than younger children. Schooling proper begins at 6 in America and in Europe and on the whole before this age in English schools there is more learning through play than later which seems to be a recognition of this fact.

Although Bruner does not contest Piaget's suggestion that there is a significant advance in the child's thought at this time his own description of it suggests that the organization of the child's thinking takes the form of ideas of identity and difference which gradually become more complex (cf. Nair in Bruner et al. 1966). But it is just because the transition seems to be an important one that Bruner chooses it as a point to test the influence upon it of language. He chose the Piagetian conservation tasks for this, as has been described. Sinclair-de-Zwart (1967) in order to follow up his work used both conservation and seriation tasks to test the influence of language and it is in the development of the understanding of seriation that the present project takes up the issue. In the present study the development of seriation is chosen rather than that of conservation because it is possible to test this by the child's behaviour independently of his spoken judgements. In studying the acquistion of conservation it is difficult not to confound speech with action. Here it is essential to observe the

effect of one upon the other. The reason for the choice of this particular transition in this area of thinking lies in the fact that it appears to be central to logical or rational development and if Piaget's account of this development is right, this, between 5 to 7 years, is the period when the child coordinates basic sets of relationships independently of their perceptual features. Bruner and also Sinclair-de-Zwart are asking how this development occurs at this period. This study has the same aim. The question in particular is 'how far and in what way does language influence this particular kind of cognitive development at this point?' But of course if there is serious doubt that this is in fact a period when the child really becomes more rational than before, or that these kinds of tasks are a valid test of such a change then the choice of task and point of development would provide very limited answers to the questions being asked. Even if linguistic influence were to be demonstrated in the task this would have little bearing on cognitive development as a whole.

The question being asked assumes that the Piagetian tasks chosen do indeed tap central rational areas of cognitive development and that they are reasonably reliable. What are Piaget's assumptions about them? As already indicated Piaget does not agree with Bruner that the child's thinking develops merely by a process of discerning similarities and differences and then organizing complex classifications. To Piaget Bruner's account assumes an empiricist epistemology which is too simple. Instead Piaget considers that preconceptual intuitive and concrete operational forms of thinking, developing in that order, are incipient forms of logic which can be characterized as logico-mathematical groupings; they are logic-like. They are not acquired by social instruction but become increasingly consistent as the individual adapts to his experience in his operative striving; the child wants to make sense of his experience. He construes it as he adapts and the most rational forms of development are like logical and mathematical structures. However Piaget and his co-workers have found considerable gaps between the acquistion of different forms of understanding. It does not all happen at once and the nature of the materials concerned in the task affects the child's grasp of the problem. For instance conservation of quantity, length and weight are not simultaneous acquisitions. Rather there are months or even years between them. This is

difficult to explain if Piaget is suggesting that around 7 years a generalised logic is acquired by the child. But when one recognizes that the logical forms he refers to are paradigms of thought it is perhaps easier to consider that something like logical understanding is gradually being constructed by the child. This is emerging competence. However its manifestation occurs in practical experience which is performance. But this 'décalage' as Piaget calls it, between different forms of logical acquisition is not properly understood.

As to the generality of the forms of understanding chosen by Bruner and then Sinclair-de-Zwart from Piaget's system, these ways of ordering experience, classifying, conserving quantity and seriating are certainly basic to mathematics and logic. Moreover they exist in simple practical ways among people who lack sophisticated technology and schooling (cf. Greenfield, 1966). But do they only develop when the child reaches 6 or 7 years? Are the tests such that they underestimate the child's rationality? Perhaps the child's inferential and classifying potential is already available long before Piaget suggests? If so, to explore the role of language in this development at the point proposed may only provide superficial information.

A brief answer to these problems will be given first and then criticisms of Piaget's approach will be considered in more detail. Finally there will be an indication of the present approach to the problem in the light of an appraisal of the criticisms.

Two interrelated doubts about Piaget's theory have been expressed above. One concerns his theory that the reasoning powers of the child are gradually constructed by the child and change in quality from being relatively simple and perceptually based forms of understanding to becoming complex and independent of perceptual features of experience; they eventually become logical. The second concerns the reliability and validity of the tests he uses as a basis of his theory. A brief answer to these doubts suggests that if other means of testing seem to imply that children are being underestimated by Piaget, one must also show that they are tapping <u>all</u> that Piaget implies if one is to refute his theory of cognitive development. Typically his critics and Piaget alike are inferring some kind of competence based upon the child's performance. Piaget may have been guilty of making loose assumptions based on too little analysis of the

nature of the tasks children are given but the same criticism may be equally levelled at his critics. Finally unless they are able to show that the sequence of cognitive growth outlined by Piaget is substantially wrong it is difficult to discount his theory in any fundamental way.

The main tenor of criticism has centred round the idea that Piaget is wrong in assuming that children under the age of 7 are not logical in their thinking, the strongest assumption being that human beings have innate reasoning powers which are complete at birth. Only motor incapacity and lack of knowledge prevent its full flowering in childhood. What evidence is there for querying Piaget's theory and for discounting his tests? Selected examples will be discussed here bearing in mind that on the whole Piaget's account of cognitive development has probably stood the test of replication more widely than any other, Lovell along with various associates having been particularly concerned with this work (cf. Modgil, 1974). In fact, from its inception Piaget's work has always evoked strong criticism, all very much to the same tune, namely that his tests underestimate children's reasoning powers hence his scheme of cognitive development is wrong. Susan Isaacs (1930) was one of the earliest of such critics. The verbal reasoning of children she observed in her Malting House School at Oxford seemed more advanced than the kind of reasoning Piaget quoted for children's conceptions of physical causality (Piaget, 1930). This controversy was inconclusive because both sets of data were only based on children's speech, uncorrelated with behaviour and in anycase Isaac's sample was probably composed of educationally privileged and gifted children. However it was such criticisms that may have turned Piaget towards behavioural tests to support his thesis. Isaacs has been followed by others who query Piaget's techniques and wish to imply a consequent weakening of his theory. Braine (1968) suggested that Piaget's tests of children's ideas of measurement of length (Piaget and Szeminska, 1952) relied too much on children's verbal judgements and that the task was confusing to the child. Improving on this he felt justified in claiming that children were likely to be two years advanced on Piaget's estimation of the age when transitive inference of length could be made. But he also felt that their notions of order correlated with this sufficiently to confirm Piaget's idea that there is a general ordinal logic appearing in these children. However he does not think that his evidence alters Piaget's

theory substantively. It merely points the need to analyse the skills required, both verbal and non-verbal, which may obscure or hinder the child's reasoning.

Bower (1974) and Bryant (1974) are among those who feel that Piagetian tasks may seriously underestimate the child's reasoning capacities. The implication is that intelligence is not gradually constructed by the child, but that given sufficient assistance within the task context he will be able to manifest his innate potential. However, for the purposes of the present project it is not clear that it matters very much whether the child is gradually constructing reasoning powers or whether he has them already only to be released by appropriate experience. It is critical to find out how his cognitive powers are either released or constructed. This is the major purpose of the project, particularly to find out how speech operates in the process. By studying the relation of speech to cognitive growth it is possible that the nature of cognitive development will become more clear. For instance, if it is the complex evolving process envisaged by Piaget attempts to hasten it (Englemann, 1971) are likely to produce unbalanced growth and this may be unstable; children may be able to apply or use specific rules or skills but they may not fully understand them (cf. Englemann, 1971, p.130). To date efforts to expedite substantially the child's development of understanding have not been shown to be stable or generalised (cf. Green, Ford and Flamer, 1971). It seems most likely that intellectual development consists at the very least in the acquisition of a variety of subskills which must facilitate reasoning (de Boysson-Bardies and O'Regan, 1973). Bénédicte de Boysson-Bardies et al. say in relation to the notion of 'transitivity':

> Piaget's "definition" of transitivity is linked with the whole structure of his system, and in particular with the idea that, for a judgement to be truly an inference, it must be "operational". For this reason, when Piaget studies transitivity using the seriation task for example, the child is only considered to "succeed" if he can "anticipate" the correct actions: if he has a programme or method to proceed, and thus shows no hesitations; or if he is able to perform modifications of the original task (such as insert a new stick into the already assembled sequence) to show that he has understood the ideas involved. (ibid. p.531).

These authors are contesting the claim by Bryant (1973) and Bryant and Trabasso (1971) that the kinds of 'inference' they think they can demonstrate in children as young as $4\frac{1}{2}$ is equivalent to the 'logical' thinking Piaget means when he talks of 'operational' development in

the child. Piaget never denies early practical forms of inference in the child; a sensori-motor generalising capacity. The child who uncovers an object he has seen covered by a cloth at sensori-motor stage IV appears to be using an immediate, here-and-now inference but he seems to have very limited powers of reflection since he does not yet search under successive covers. Later developments reveal a gradual extension of practical reasoning which is highly dependent upon the assistance provided by perceptual features of the activities engaging the child. Woodward (1974), Greenfield (1972) and Bryant (1974)* all independently demonstrate that partial seriation skills are available to children from 3 - 4 years onwards although Bryant does not recognize these as limited achievements. Such children can order a three element series as if they were in possession of the notion that if A>B>C then A>C but they cannot interpolate items in a series of more then 5 or 6 elements. This suggests that they do not understand the general transitive relations inherent in series and as will be discussed in the next chapter, they cannot do this efficiently if the series is hidden from view. The fact that there is success when separate and few items are ordered suggests that perceptual features can be used piecemeal to achieve the result. If cups are nested there is a given base as well as tactile evidence from inserting cups within each other. It seems that perceptual assistance enables children apparently to seriate much earlier than Piaget would claim. Indeed Bryant and Trebasso (1971) believe that children can use transitive inference much earlier than Piaget allows. They claim that children are prevented from using this reasoning by the difficulty of the Piagetian tasks, difficulty which is extraneous to the reasoning itself. According to them it is only the difficulty they have in remembering what they saw when they compared A>B and separately B>C that prevents them from deducing that A>C. Children in one of Bryant's experiments were given practice in seeing 5 elements A>B>C>D>E, separately presented to them in pairs. They learned to describe them in order in one direction and then in the other (this, in order to prevent them from learning a parroted set of relations). This meant that one pair B D had not been seen together or described in relationship to each other. When later children were asked to describe the relations of pairs, without then seeing their lengths correct answers to the B D relation were significantly better than chance. From this Bryant concludes that deductive transitive inferences can be made by children at a

* Footnote. Also Siegel (1972). See p.29 Chapter 2.

younger age than Piaget admits (children of 4 years). The implication for him seems to be that they do indeed have innate general reasoning potential which is not different in kind from that of adults. Useful criticism of Bryant's experiments and conclusions is made by Youniss and Furth (1973) and de Boysson-Bardies and O'Regan (1973). But the present issue demands careful consideration of the nature of tasks that seem to manifest seriating capacities in children which Piaget would call 'operational' and those he would not. Briefly, the simpler tasks convey more perceptual information but in addition, it is not the same reasoning to infer from A>B>C to A>C in a three element series or even one of five elements such as that used by Bryant, as that required for inserting elements in a longer series, particularly if the long series is covered and the only clues allowed for placement are successive comparisons of the insertion item with those in the series. The first operation can be effected by means of imagery and the relations considered are in one direction only. The relations of B to D in Bryant's series could easily be envisaged in this way in spite of not seeing the two items compared together. But Piaget regards seriation as a combination of the understanding of order and transitivity in the child. The most critical test of this is to insert an extra element into a series and in order to effect this the child must appreciate opposing sets of relations in the one set of objects which have been ordered. This means bearing in mind any sequence of at least ten elements in any orientation. The insertion of an element in any such series especially if the items are covered from view entails the understanding of opposing relations of any item in the series, and it means attending to two or more features of a set (base-line and top of rods). It also requires the child to discount perceptual features of any previous sets he may have used for seriating. The present study has revealed some of these complex features inherent in operational seriation skills but central to the formal general understanding Piaget appears to have in mind is the realisation that each item in a series is uniquely placed by its opposite relationship to those on one side of it to those on the other. The <u>coordination</u> of opposing sets of relationships is what Piaget has in mind and which he regards as a logical function which children begin to acquire between 6 and 7 years. He is not assuming that experience has no influence in this development thus it is not damaging to his thesis if some subjects manifest this understanding before 7 years. Least

of all is it damaging to show that relatively young children are capable of some features of this coordinated form of understanding, especially if they do so with extra perceptual assistance for this is just how Piaget sees logical understanding emerging. But essentially it is perhaps worth reiterating the point made on pages 18 and 21 that since the aim of this study is to find out how cognitive development occurs in relation to speech it is immaterial whether the reasoning concerned is an innate potential or whether it is constructed by the individual out of experience in the course of development as Piaget suggests. Criticisms of Piagetian tests, those of seriation in particular, do not provide a fundamental objection to their use as a means of assessing the effect of speech on cognitive development in this project. Naturally it cannot be assumed that the influence of speech will operate in the same way for other forms of understanding and at different points in development but seriation is a sufficiently general form of cognitive understanding to be a significant feature to study in relation to speech. Moreover it seems clear overall that between 5 and 7 years there is an interesting and important transition in the child's cognitive capacity characterized by an emerging ability to coordinate sets of relations. This in itself may be a particularly fruitful point at which to study the influence of speech since combined relationships are being formulated here.

In chapter 2 which follows a detailed account of how this is essayed will be given in a study based on that of Sinclair-de-Zwart (1967).

Chapter 2

THE INFLUENCE OF LANGUAGE TRAINING ON SERIATION OF 5-6 YEAR OLD CHILDREN INITIALLY AT DIFFERENT LEVELS OF DESCRIPTIVE COMPETENCE

Discussion in chapter 1 has led to the view that the relation of language to the development of thinking must be dealt with at a specific point in development in relation to specific tasks concerned with a specific kind of thinking. If the chosen point is one which can be regarded as central to the development of thinking, then findings on the relation of speech and understanding specific to this context will be of wider interest for developmental psychology.

Because Sinclair-de-Zwart's (1967) study was the last word to date in the controversy between Bruner and Piaget this seemed likely to be a useful basis for present considerations. Since her study has not been repeated and since Piaget consistently quotes her findings to support his theoretical position (Piaget 1970a, 1970b, 1971b) his reliance upon this work should be tested. Indeed as mentioned previously (p.15) Piaget admits that Sinclair-de-Zwart has merely broached the matter. What then of her study? How reliable was her method, how definitive her findings and what reliance can be placed on her conclusions?

Sinclair-de-Zwart was attempting to compare levels of thinking with what she called 'their linguistic subsystems' (Sinclair-de-Zwart, 1967, p.11) and to counter Bruner's (1964) claim as to the primacy of specific language at the transition to operational thinking. She found that subjects who were pre-operational in conservation of continuous quantity and in seriation, according to Piaget's scheme, were in each case limited to uncoordinated descriptions (e.g. 'this crayon is big', and of the same object, 'this crayon is thin'). When describing size differences they gave global descriptions (e.g. 'big' or 'little'). Utterances which unite compensating dimensions when conserving quantity or which reversibly compare sizes (e.g. for the former, 'this crayon is tall but thin', or the latter, 'bigger/smaller') were the prerogative of children who understood the underlying logic of conserving quantity or of uniting asymmetrical size relations. In tasks of comprehension all children were successful. She bases her contention that language cannot mould thought principally on her attempt to train pre-operational subjects in the expressions typically used at an operational level. In two experiments involving conservation of continuous quantity and seriation she claims to have found negligible progress in the development

of logical thinking consequent upon such training. For her seriation training experiment Sinclair-de-Zwart selected 23 Genevan pupils at 'pre-operational' and 'intermediate' levels of seriation according to Piaget's scheme outlined here in Fig. 1. After three sessions of training in the appropriate use of the relevant descriptions (e.g. 'bigger/smaller') they were re-tested for progress in seriation the next day and two weeks later. The subjects, we are told, were all average or above average in intelligence and between 5 and 6 years of age. Presumably they were at a comparable linguistic level initially. There was no control for effects of training. Testing procedures involved eliciting the description of a series, testing for comprehension, and then giving the seriation tasks. As to the first, the child was asked to describe a set of rods each of a different length assembled in order of size by the observer, first as to the whole configuration and then the relations of individual elements in ascending and descending order. Comprehension was tested by response to instructions in this context. From Sinclair-de-Zwart's account of the seriation tasks we glean that the child was asked to construct such a series himself from a jumbled pile of rods and also either to interpolate a second series of rods of intermediate lengths or to construct a series correctly which was screened from view by selecting each element in order of size. It appears that the criterion of 'operational success' was efficiency in either of the last two tasks. Post-tests replicated the pre-test. The account of Sinclair-de-Zwart's language training is more thorough. It is adhered to with only minor additions in the present work. She stressed training in the description of the middle item of three ('the description of 3 elements'), namely where A>B>C, the child learned to describe B as both <A and >C. However the child's ability to make such a description was not tested by her either before or after training. Her outline of parallel linguistic and logical categories is set out in Fig.1. Although she notes a slight tendency for the former to precede the latter in development, she regards this as an 'automatic' manifestation. She places special emphasis upon the fact that learning difficulties were probably logical rather than linguistic. These were learning to substitute bigger/smaller appropriately and, above all, learning to describe B in respect of A and C, 'the middle of 3 elements'. Only 12 subjects mastered this last description. As regards progress in seriation, according to Sinclair-de-Zwart, 18 of the 23 subjects made some logical advance, seven of whom reached an operational level of

seriation but only three of these made substantial progress across substages. Such progress is thought by her to be of little consequence.

That Sinclair-de-Zwart had set up a test of counter-views at a specific and sufficiently advanced cognitive and linguistic juncture in development provided some of the necessary ingredients for studying the problem in hand, but her methods lacked precision. This left the question open for further investigation. Points of uncertainty in her study which appear to be of particular importance are: lack of controls for effects of training, or of comparisons of these effects upon subjects at different initial levels of descriptive competence; insufficient detail about seriation procedures and coding, with consequent ambiguity as to behavioural criteria for allocation to substages and as to measures of progress; the omission from the tests of what may be the most critical description - 'the description of 3 elements' - thus precluding comparison of this with the final transition to an operational seriation level; and doubt as to whether language training was strongly didactic or open-ended in quality. Finally, no results for the second post-test were given on the grounds that they did not differ from those of the first. Some differences must have occurred if detailed protocols are to be believed, and since no statistical tests are made at any point, what constitutes a 'significant difference' remains a matter of opinion.

The present experiment therefore attempts to repeat the language training experiment of Sinclair-de-Zwart in seriation and in addition to compare two groups of children one of which (lower working class, LWC) may possibly be relatively less efficient than the other (middle class, MC) in the appropriate use of the specific comparative expressions 'this one is bigger/smaller than that one'. According to Bernstein (1973) the LWC child is likely to be confined to a restricted code of language use whose function is to preserve the social structure, whereas MC children have also at their command wider uses of language, in particular, one which functions to analyse the world of objects and their relationships through independent thought. This kind of difference was found by Robinson & Rackstraw (1972) in answers of mothers to typical questions of five year olds and in answers given by seven year old children. The present author (Heber, 1974) also found similar social class differences in the questions asked by seven year old boys. These findings were consistent with Bernstein's idea that LWC children

are not orientated to the use of language as a tool for discovery and analysis of cause and effect. Thus it is probable that they are at a similar disadvantage in the use of expressions required to describe a logical structure such as a series of asymmetrically arranged elements. Children who have this disadvantage may perhaps be expected to advance in this logic as a consequence of specific language training according to the degree of importance of such language at this point in the development of the particular logical structure. Thus according to two theoretical extremes, the one assuming that language is a major influence in the development of logical thinking, the other that it is irrelevant to this, one would expect the LWC group either to make significant progress in seriation or not, whereas the MC group would not be affected in either case. Probably, as oversimplifications, neither prediction is likely to be entirely correct. In particular, one should note that the first explanation assumes 'language' to have a function independent of context, a feature which is clearly not characteristic of the descriptions in question here. However, it is hoped that in this experimental situation differential patterns of progress in logical thinking following training in language will throw some light on the nature of the relation in question.

SPECIFIC ANALYSIS OF THE PROBLEM

According to Piaget, operational seriation is the logical level of understanding of the organization of elements in a series arranged in asymmetrical transitive relationship along some dimension. The dimensions in the present experiment are size and length. In the Piaget/Sinclair-de-Zwart analysis this appears to require an understanding by the child of both ascending and descending relations which characterize this kind of arrangement, and also, that each item occupies a unique position within it as both bigger than those below and smaller than those above it. The coordinated understanding by the child of the definitive characteristics of asymmetrical series is thus a complex organization of ideas which exceed the perceptual skills which enable a child to place only four or five elements in a series. It is for this reason that Woodward (1974) points out the necessity to analyse the task in order to isolate the critical logic of Piaget's requirements. Although Piaget and Inhelder (1969) claim that only

at about 7 years do three quarters of children reach a full understanding of seriation by their criteria Siegel (1972) claims that children of only 3 can seriate, but she used only four elements (cf. p.22 chapter 1). Indeed, as previously mentioned (p.22) Woodward (1972) has shown that children as young as $4\frac{1}{2}$ and even 3 in some instances can easily seriate nesting cups. Such a task provides tactile and visual assistance to the child. Thus Woodward (1974) emphasises the need to find behavioural criteria to test the child's understanding of the unique position of each element in such series. Piaget and Sinclair-de-Zwart, as has been noted (p.26), believe that either selection by size or interpolation of extra elements are sufficient alternative criteria upon which to assume that the child does fully understand series. Woodward (1974) devised a task which required the child to insert extra elements into a covered series. This task she claims differentiates 5 to 6 year old from 7 to 8 year old children significantly better than Piaget's tasks of selection by size or inserting extra elements into an open series. The present author, following Woodward (1974) has adopted a single criterion. This requires the insertion of an extra item in a covered series by systematic comparison with items on both sides of the point of insertion. To give a definitive description of this set of relations one must first select the relevant attribute (viz. size), next the type of relation (viz. difference) and then the specific nature of this difference (viz. that it is asymmetrical throughout). The comparative terms bigger/smaller must be used interchangeably as required in order to indicate the general characteristic of the series (viz. A>B>C therefore C<B<A). Finally these terms must satisfactorily describe the necessary simultaneous relations of each element to those on either side of it (viz. where A>B>C, B is both >C and <A 'the middle of 3 elements'). Clearly then the appropriate and definitive description of this configuration out of context is impossible. Figure 1 shows Sinclair-de-Zwart's analysis of descriptions according to the developmental sequence she accords them placed opposite levels of understanding of seriation in Piaget's scheme to which she claims they are developmentally parallel (Fig.1, columns 1 and 2). In addition are listed the criteria for a definitive description appropriate to seriation levels as discussed in this paper (Fig.1, columns 3 and 4).

FIGURE 1. SERIATION AND THE RELATED DESCRIPTION: COMPARISON OF SINCLAIR-DE-ZWART'S AND PRESENT ANALYSIS

Sinclair-de-Zwart's analysis		Present analysis	
Descriptions given by the subject	Seriation: levels of understanding ordinal size relations, based on Piaget	Descriptions: comparable levels analysed for both O and S	Seriation: - in 6 tasks behaviour featuring degrees of competence in ordering items by size: type of construction and amount of self-correction; type of selection; sequence of comparisons for interpolation.
I 'dichotomie' e.g. 'big', 'little'.	Ia) No success in seriation (preoperational).	a) Relevant attribute e.g. 'size'.	a) Random selections, placement and comparisons. No corrections.
II 'trichotomie' e.g. 'big', 'middle-sized', 'little'.	Ib) Small uncoordinated series (preoperational).	b) General relation e.g. 'difference'.	b) Slight evidence of grouping by size e.g. big/little, also spot comparisons.
III 'labelling' e.g. 'mummy', 'daddy', 'baby' etc.'		c) Descriptive use of terms e.g. 'big', 'little'; 'big', 'middle-sized', 'little'; 'mummy', 'daddy', 'baby'.	c) Rough selection by size; laborious but correct assembly of items in size order. For insertion, some sequential comparisons.
IV 'one-way' use of comparative terms e.g. 'bigger' or 'smaller'.	II Success through trial and error (intermediate).	d) 'one-way' use of comparative terms, e.g. 'bigger' or 'smaller' i.e. terms not used interchangeably and appropriately.	
V Interchangeable and appropriate use of 'bigger/ smaller'.	III Competent size ordering and correct interpolation of intermediate length items or selection by size (operational).	e) Interchangeable and appropriate use of comparatives e.g. 'bigger/ smaller'.	d) Effective achievement by trial and error. Some sequential comparisons and occasional comparisons on both sides of insertion.
('description of 3 elements' only used in training by Sinclair).		('description of 3 elements' tested and separately analysed in present study).	e) Competent arrangement and selection in order of size and insertion of extra item into covered series by systematic comparisons with elements on both sides of point of insertion - 'the double comparison strategy'.

METHOD

Design

Two groups of children were selected and matched on tasks of seriation as being at 'preoperational' and 'intermediate' levels. In each group there were ten experimental subjects and ten control subjects making 40 in all. The independent variable was social class. Experimental children in each group were given specific language training in the use of comparative terms as typically employed by operational seriators and all subjects were tested subsequently in seriation tasks on two occasions, the first within a day or two of training and the second two weeks later. Tasks of description and comprehension were included in the pre-test and post-tests.

Subjects

The subjects were children of semi- and unskilled workers (designated lower working class - LWC) drawn from a school on a Council Estate, and children whose parents were professional or clerical (designated middle class - MC) from a school drawing from a mainly middle class residential area. Both schools were in the city of Southampton. Four of the MC group (2 experimental and 2 control) came from a second school of mixed social class intake. Despite differences in catchment areas all the schools employed similar child-centred methods. Selection for interview was in alphabetical sequence selected by social class, commencing with six year olds and lowering the age as necessary. Operational seriators were dropped while the remaining 'preoperational' and 'intermediate' stage children were alternately allocated to experimental and control groups. The mean ages arrived at in this way were: MC Es mean = 5•7; Cs mean = 5•6; LWC Es mean = 6•1; Cs mean = 5•9. All subjects were boys and were without obvious sensory, intellectual or emotional handicaps.

Materials

I. For seriation tasks. These materials and tasks are an extension of Piaget's and are based on those of Woodward (1974). They differ from the original techniques in the number and variety of tasks, thus providing varied dimensions. The last three covered sets, where one extra item must be interposed in the existing series by means of single sequential comparisons with items in that series, are in lieu of Piaget's interpolation task and/or Sinclair-de-Zwart's 'screen test',

although this last is included as task 3 here.

1. Loose sets. Three sets of ten rods, made of wooden square dowel, each set of a different colour (a) yellow, (b) red, (c) blue, each differing in overall size dimensions and regular or irregular differences in length between items. Two boards upon which arrangements of rods could be made.

2. Covered sets. Three grooved boards of natural colour plywood with raised equidistant divisions of matt black. Three sets of ten rods with similar types of difference between sets and items as above, the rods to run in the grooves. For each set, nine extra rods of contrasting colour to the first ten, and of intermediate lengths so that when inserted they completed an asymmetrical series in each case. Plastic laminated cardboard covers for each board. An extra board and set with five main rods and four insertions for demonstration. These sets were: (d) blue and yellow with yellow cover, (e) green and white with purple cover, (f) red and blue with blue cover. The extra demonstration set was white and red, the cover red. Colours were chosen to give pleasant variety but also helped in identification.*

II. Training materials. Two sets of ten pairs of model slippers (one set blue, one set green) backed with glass paper, of constant proportionate increase in length and breadth from 2·5 - 16 cm in length. One board faced with beige brushed nylon 9 cm by 30 cm.

PROCEDURE

All children selected for the experiment were interviewed individually on six occasions each session lasting from between 10 to 40 minutes approximately, depending on individual needs. These sessions comprised: (i) a pre-test for selection, operational seriators were dropped at this point; (ii) three 'language' training sessions; (iii) two post-tests, the first approximately one day after the last training session, the second two weeks later. Children in the control groups had similar treatment omitting the training sessions. Sessions were tape recorded except where seriation tasks

* Photographs of the sets of rods giving exact measurements are in Appendix I.

were confined mainly to action, when written records were made by the observer. Children did not appear to be distracted by either type of recording.

Pre-test

(i) Description. The loose series set (a) was assembled by the observer and the child was asked for a description, first of the whole (e.g. 'a staircase') and next of the relations of individual elements in two directions (e.g. 'bigger/smaller') the order being varied. Three items were then isolated, A>B>C, and the child was asked to describe B in relation to A and C. This was termed 'the description of three elements'.

(ii) Seriation. The child was asked to perform six seriation tasks after he had been shown a completed series which had previously been constructed out of sight by the observer, using set (a). These were: task 1 arranging the jumbled elements of 'loose' set (b) 'to make a staircase'; task 2 a similar procedure using set (c); task 3 selecting elements from jumbled set (a) 'in the right order to make a staircase' and handing them one by one to the observer for assembly behind a screen (Sinclair-de-Zwart's 'screen test'); task 4 using the extra covered demonstration set, the observer illustrated the correct insertion of one extra rod, comparing it sequentially with rods one at each end of the covered items. The cover was then removed to show the correct position of the extra item in the series. Then, using set (d), the subject was asked to insert one extra item as in the demonstration procedure and encouraged to 'look at' as many of the rods from the existing series as he liked, but only one at a time, before he chose the point of insertion. The cover was then removed and the child encouraged to judge his degree of success and allowed extra trials if he desired. Tasks 5 and 6 were similar to task 4 using covered sets (e) and (f) but without demonstration.

(iii) Comprehension. The child was asked to respond to a set of commands which required comprehension of the comparative terms 'bigger/smaller' using rods of different lengths.

For descriptions and for seriation tasks, prompting was varied according to individual needs in order to ensure that the child understood what was required of him and was responding as far as possible at his optimum level. Children were always asked to judge their degree of success in each of the seriation tasks and encouraged to make any corrections they deemed necessary.

Language training

Following Sinclair-de-Zwart, practice was given in the appropriate use of the expressions 'this one is smaller/bigger than that one'. This description referred to a single set of slippers previously set out by the observer in size order. Each item in relation to the next was described in ascending and descending order. Then the observer added the pair to each slipper in the series and this correspondence was noted by the child. Finally the child was led to describe 'the middle 3 elements' e.g. A>B>C, but before B alone was related to A and C, a middle pair B and B' were included and the child was asked to describe B in relation to A, and B' in relation to C. These exercises were repeated until the child had mastered the descriptions concerned. This level of competence was achieved at some point during the three training sessions by all subjects, care being taken to maintain interest throughout. As far as possible in this experiment descriptions were elicited by open questioning, a method which may allow the child to incorporate his own utterance appropriately and may thus be in keeping with Piaget's theory of 'self-regulation'.

Post-tests

Both the immediate and the delayed post-tests replicated the pre-test.

ANALYSIS OF DATA

Seriation

The types of behaviour chosen as representative of the child's understanding of size order relations were: his strategies of selection and comparison of rods; whether corrections were made and whether these were spontaneous; the type of achievement and the child's judgement of this. According to this framework behaviour was classified into five categories ranging from less to more competent for the first three and last three tasks (see Fig.1). In tasks 1-3, this ranged from random selection and two-way grouping of rods, e.g. 'big', 'little', the child being apparently satisfied with this achievement, to correct spontaneous ordering by size. In tasks 4, 5 and 6 the first category of behaviour consisted in arbitrary interpolation, the child making no comparisons despite prompting and being apparently unable to recognize errors. The most advanced category was that thought characteristic of an operational understanding of seriation namely, that the insertion

rod should be systematically compared with those on either side of it before placement, this being the only logical means of ensuring success. This was termed 'the double comparison' strategy.

Descriptions

These were judged as to whether they were contextually appropriate. They were categorized according to the specifications mentioned in Fig.1, namely at five levels, from a general description of the configuration to a precise and appropriately reversible account of size relations. Differences from Sinclair-de-Zwart's analysis can be seen from this figure; for instance, items from her middle categories were too sparse in the present data to justify separation here. It also seemed important to analyse and count the utterances of both the observer and the child since this dialogue might reflect differences in 'language use' between groups. Descriptive units were semantic and functional in the sense that each attempt to describe a particular relation in the series of rods, whether grammatically complete or not, was counted as one unit.

TREATMENT OF RESULTS

Individual levels in seriation tasks and descriptions were scored on a five-point scale in each case (1-5, or a-e) and these levels were compared before and after training between experimental and control subjects within each group (MC and LWC) and also between these groups using the Mann-Whitney U test. The progress of individual subjects in seriation is illustrated in Table I p.36 and results of the comparisons of scores between groups in seriation are collated in Table II p.37 and for descriptions in Table III p.38. Histograms summing prompts and responses for all subjects in response to the observer for the pre-test and the two post-tests (test sessions I, II and III) are shown in Appendix II pp.162-4. Advance between sessions was assessed for all groups using the Wilcoxon matched-pairs signed-ranks test. Progress in seriation was judged by counting the changes from initial score in the five-point scale whether positive or negative. The percentage of moves which could theoretically be of 1-, 2-, 3- or 4-step size across the scale was calculated for each of these amounts respectively. Descriptive competence was measured by the relative number of responses at level 'e' taken as a percentage of the total number of prompts for each individual.

TABLE I Progress in seriation

- Changes scored 1 point for each forward 'step' on scale 'a - e', -1 for reverse steps. Moves in any task could comprise 1, 2, 3 or 4 steps.

	MC Es subjects										
Sessions changes	A	B	C	D	E	F	G	H	I	J	Totals
I-II	7	10	2	6	5	6	7	10	6	12	71
II-III	0	2	1	1	0	0	7	(-1)	7	(-1)	16
Total	7	12	3	7	5	6	14	9	13	11	87

	MC Cs subjects										
Sessions changes	a	b	c	d	e	f	g	h	i	j	Totals
I-II	6	1	0	3	1	1	2	(-1)	5	1	19
II-III	1	1	1	0	1	0	1	1	-1	0	5
Total	7	2	1	3	2	1	3	0	4	1	24

	LWC Es subjects										
Sessions changes	K	L	M	N	O	P	Q	R	S	T	Totals
I-II	4	1	3	8	3	0	2	3	7	3	34
II-III	3	(-1)3	2	(-1)3	2	3	7	4	(-2)3	3	29
Total	7	3	5	10	5	3	9	7	8	6	63

	LWC Cs subjects										
Sessions changes	k	l	m	n	o	p	q	r	s	t	Totals
I-II	3	(-3)	(-2)	0	(-1)	0	0	0	0	(-1)3	-1
II-III	0	1	1	3	3	(-1)5	0	1	1	1	15
Total	3	-2	-1	3	2	4	0	1	1	3	14

TABLE II

Progress in Seriation - Comparisons at Pretest of mean scores in six tasks with changes at Post-test I and II and Total

Within groups Experimental subjects (Es) versus Control subjects (Cs)
Between groups LWC versus MC using the Mann-Whitney U test
Between sessions using the Wilcoxon matched-pairs signed-ranks test

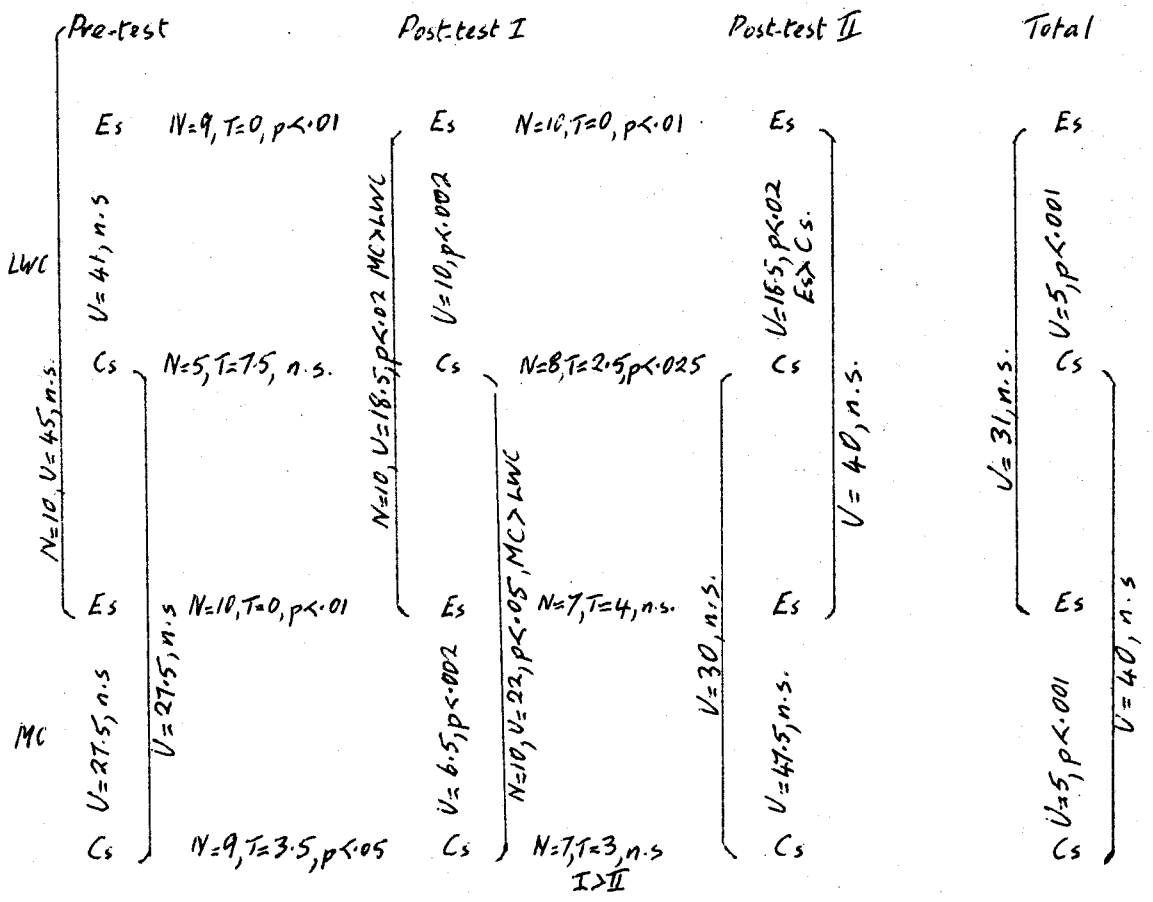


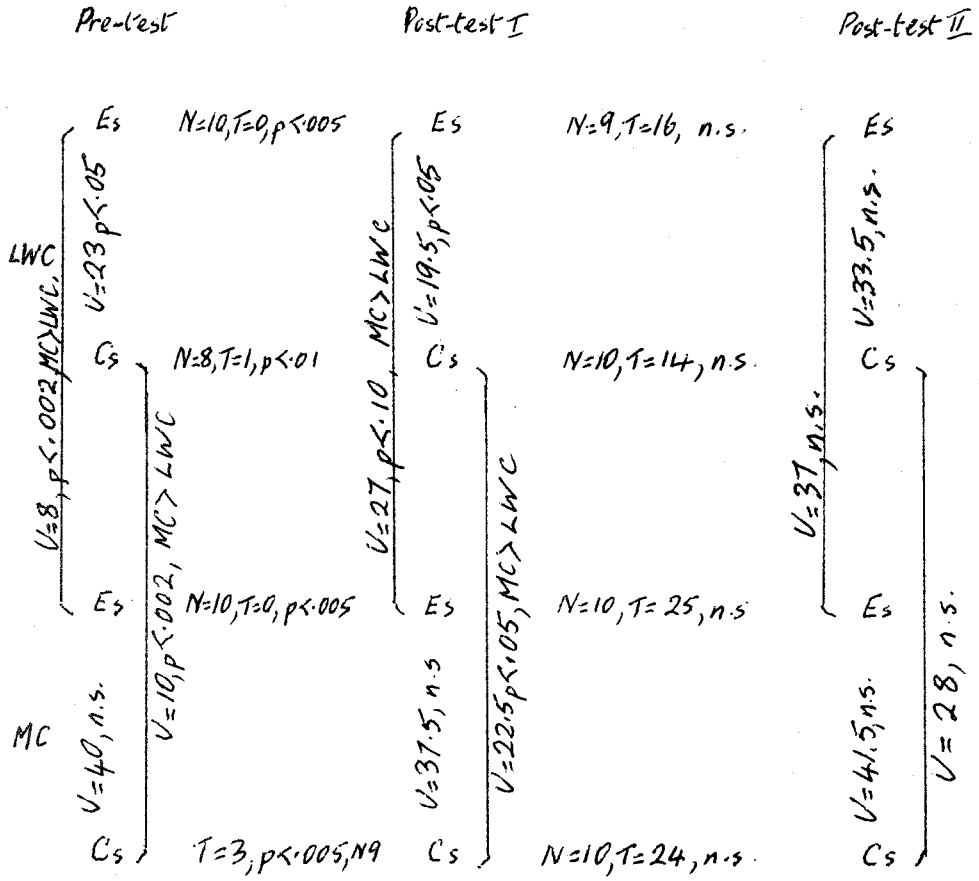
TABLE III

'Descriptions' comparisons at Pretest, Post-tests I and II

Within groups Experimental subjects versus Controls (Es v Cs) using Mann-Whitney U test

Between groups LWC versus MC using Mann-Whitney U test

Between sessions using Wilcoxon matched-pairs signed-ranks test



Comparisons of the percentage of appropriate comparative utterances (level 'e') of total number of prompts for each child, not including the 'description of three elements'.

RESULTS

Analysis of seriation tasks

Consistent results were obtained from the six tasks: (product moment correlations of tasks 1-3 were: 1 and 2, r=0•86, P<0•001; 2 and 3, r=0•58; 1 and 3, r=0•54, P<0•01. Tasks 4-6: 4 and 5, r=0•94; 5 and 6, r=0•95; 4 and 6, r=0•84, P<0•001. Tasks 1-3/4-6 summed: r=0•54, P<0•01; d.f.=38 - initial scores for 40 subjects). Progress between sessions was fairly uniform with little fluctuation. Initial scores were represented at both 'preoperational' and 'intermediate' levels, there being equal progress from all. Matrices on pages in Appendix II illustrate changes in seriation scores for all subjects between sessions I and II and I and III for tasks 1, 2, 3, and 4, 5, 6. Mean scores in all six tasks for all experimental subjects for sessions I, II and III are shown in Table I of Appendix II p.161 and for the frequencies of scores for the five stages of understanding seriation in each group (MC and LWC) for experimental and control subjects in Table II p.161 of Appendix II. Overall comparison of <u>initial</u> seriation levels between groups showed no difference (MC/LWC Es U=45, n.s.; Cs U=27•5, n.s.; MC Es/Cs U=27•5, n.s.; LWC Es/Cs U=41, n.s.).

'Language'; descriptive levels compared

(1) Median percentage of responses at level 'e' to prompts, for both groups were: Es pre-test LWC 55•35, MC 156•3; post-test I LWC 462•5, MC 750; post-test II LWC 412•5, MC 587•5. Cs pre-test LWC 22•25, MC 200; post-test I LWC 145•45, MC 483•3; post-test II LWC 275, MC 493•3.

(2) Initially: the MC were clearly more competent than the LWC group (MC>LWC Es U=8, P<0•002; Cs U=10, P<0•002); experimental and control subjects were not different in the MC group (U=40, n.s.) although LWC controls were less advanced than their experimental counterparts (U=23, P<0•05).

(3) After training: these comparisons showed that MC experimental as opposed to control subjects continued to be better, though not significantly so, than LWC subjects at the first post-test, but that this deficit had been dissipated by the second post-test (<u>post-test I</u> MC/LWC Es U=27, P<0•10; Cs U=22•5, P<0•05)(<u>post-test II</u> Es U=37, n.s.; Cs U=28, n.s.).

(4) Between sessions: progress from pre-test to post-test I was significant for both groups of experimental subjects and their controls and in both cases there was no further significant improvement

in descriptions from post-test I to II (at post-test I Es LWC T=0, n10, P<0•005; MC T=0, n10, P<0•005; Cs LWC T=1, n8, P<0•01; MC T=3, P<0•005)(at post-test II Es LWC T=16, n9, n.s.; MC T=25, n10, n.s.; Cs LWC T=14, n10, n.s.; MC T=24, n10, n.s.).

Progress in seriation

After training the changes between levels 1 to 5 which theoretically could be moves of a one-step to as much as a four-step type between substages, and which were summed across the six tasks for individuals, at best consisted in progress from levels 2 to 5 in the first three tasks or from 1 to 4 in the second three in two out of three tasks ('3-step' moves). But 'one'- and 'two-step' moves were usually the case. The percentage of all moves which were of a 1-, 2-, 3- or 4-step type respectively were: Es MC 61, 30, 9, 0 per cent; LWC 74, 22, 4, 0 per cent; Cs MC 79, 20, 0, 0 per cent; LWC 88, 12, 0, 0 per cent. No subjects used logical strategies systematically, i.e. level 5 in tasks 4, 5 and 6, and therefore none became 'operational seriators' according to the present criteria. But it is clear that systematic perceptual strategies of selection and comparison of rods were developing, whilst logical techniques were emerging on occasions. These were used by seven subjects, five experimental (3MC, 2LWC) and two MC controls. Mean score levels for the MC and LWC groups at sessions I, II and III for the first and second three tasks respectively were: I MC 2•3, 1•6; LWC 2•2, 1•6; II MC 3•6, 2•6; LWC 3•1, 1•8; III MC 4•1, 2•8; LWC 3•6, 2•4.

Comparisons of progress in seriation

All experimental subjects made significantly better progress than controls (post-test I MC Es>Cs U=6•5, P<0•001; LWC Es>Cs U=10, P<0•001) (post-test II MC Es/Cs U=47•5, n.s.; LWC Es>Cs U=18•5, P<0•01)(total MC Es>Cs U=5, P<0•001; LWC Es>Cs, U=5, P<0•001). MC experimental subjects were in advance of the LWC at the first post-testing but were subsequently equalled by the LWC group of post-test II (post-test I MC>LWC U=18•5, P<0•02; post-test II U=40, n.s.; total U=31, n.s.). Comparisons of control subjects between groups were similar (post-test I MC>LWC U=22, P<0•05; post-test II U=30, n.s.; total U=40, n.s.).

Between sessions most progress was made by the MC group at post-test I, a level which did not alter significantly by post-test II (pre- to post-test I Es T=0, n10, P<0•01; Cs T=3•5, n9, P<0•05)(post-test I to post-test II Es T=4, n7, n.s.; Cs T=3, n7, n.s.). Among the LWC progress

continued between the three sessions (pre- to post-test I Es T=0, n9, P<0•01; Cs T=7•5, n5, n.s.)(post-test I to post-test II Es T=0, n10, P<0•01; Cs T=2•5, n8, P<0•025).

The relation of 'language' to 'logic' is such as to link pre-test descriptive competence to post-test progress in seriation in each experimental group. This may be illustrated by correlating pre-test 'level e' descriptions to total seriation progress (MC rho=0•61, P<0•05; LWC rho= -0•03, n.s.). A similar pattern may tentatively be suggested for initial competence in describing 'the middle of 3 elements' which was possessed by the three MC experimental subjects who subsequently and in contrast to others began to use 'logical' - 'double comparison' - strategies in the insertion tasks. Two of these subjects began to use the 'logic' at post-test I, the third in two of the three tasks at post-test II. The two LWC experimental subjects, without having the initial description began to use this 'logic' each in two tasks at post-test II. Of the two MC control subjects who eventually used the 'logic', one initially had the description.

Summary of results

Two groups of children (LWC and MC), initially at different levels of competence in describing size relations were selected as comparable in seriation. Thus selected, mean chronological ages were six months less in the MC group (CA, MC 5½, LWC 6). Experimental subjects in each group then had training in the appropriate use of the descriptions, e.g. 'bigger/smaller'. Control subjects did not. All subjects were subsequently tested for progress in seriation. Differences in descriptive competence were most apparent in the relative number of prompts required to elicit appropriate descriptions. This was significantly higher in the LWC group who similarly needed longer training sessions than the MC children. Learning difficulties related to giving reverse descriptions appropriately but were most intractable for describing 'the middle of 3 elements'. Nevertheless all subjects achieved the required descriptive competence by the end of three learning sessions and all were initially able to comprehend the comparative terms concerned. The type and amount of progress in seriation was assessed in six tasks where improvement in systematic strategies of selection and comparison of rods was clearly emerging. In this manner a minority of subjects advanced as much as two or three substages in one move on a five-point scale, although most subjects only progressed by one step at a time.

All but a few unsystematic attempts by seven children (5 Es, 2 Cs) relied on perceptual judgements and thus according to the criteria set here, none fully reached an operational seriation level of understanding. Progress was significantly better among experimental groups than the controls, and MC subjects (to whom the appropriate use of descriptions was initially available) made significantly better progress than the LWC group immediately after training. This difference was equalled by the LWC two weeks later without further training. The characteristic pattern of progress for each experimental group respectively occurred among controls though significantly less in amount. The positive relation of initial descriptive competence and prompt progress in seriation appears also to occur for the 'description of the middle of 3 elements' and the development of subsequent 'logical' seriation strategies.

DISCUSSION

Detailed comparison of the present findings with those of Sinclair-de-Zwart is precluded by differences in method and design, but in general it is probably fair to suggest that the progress in seriation which followed 'language training' was similar in type and amount in both studies. The control groups used in the present study allows one to see that progress is significantly related to 'language training' and differences in descriptive competence. Clearly the learning difficulties encountered in both studies were similar and this is germane to the problem if it is agreed with Sinclair-de-Zwart that they are logical rather than linguistic in nature. But here, one is free to shift from Sinclair-de-Zwart's cognitive emphasis to an interpretation which includes combined linguistic and social influences in an active relation with the emerging logic of the individual. The present method of dealing with the problem of the relation of 'language' and 'logic' in development has been to compare progress in the latter upon the provision of 'language training' to subjects initially at different levels of descriptive competence.* In this circumstance it may be hypothesized that to the extent that 'language' and 'logic' are thought to <u>interact</u> in some way, initial presence of appropriate 'language'

* The terms 'language' and 'logic' are used here as short-hand to apply to the specific aspects of each with which we are concerned in the present experiment.

at each successive point of 'logical' progress might be the condition giving rise to more rapid effects from training in 'language' than an initial lack of such 'language'. It is this theoretical position which best fits the results of the present experiment. Here it seems that the influence of 'language' in cognitive development, at least as it concerns seriation and the related description, is something more than a 'medium' or channel of representation, and less than a 'mould' of developing thought. Rather results seem to point towards the idea of some more complex interactive process of developing speech and cognition; one in which the developmental flow must preclude any static or wholly malleable features, either linguistic or cognitive. The changing flow of linguistic usage appears in the fact that comparative terms are comprehended by all subjects in some sense and differences in descriptive competence between groups lay in the precision of reference which was more or less easily elicited in dialogue over a period of time. In fact progress was occurring in all subjects including the controls. The control subjects progressed significantly less in amount than experimental subjects but preserved the timing pattern typical to each group respectively. Thus a characteristic descriptive-logical process was continuing under the influence of tests alone. But the 'language training' was all in the speech mode, which is a flexible and rapid medium of reference and in this context constrains analysis of the particular essential relations. Furthermore, much of this referential focus must be derived from the nature of the dialogue itself which in turn may instigate and expedite conscious reflection. Such reflection would not only probe details of the constancy of relations in this particular logical organization but might tend to detach the descriptions from their specific context by generalization to all parts of a series and among perceptually different sets. The speech being dialogue, moreover, both draws from the child the precise references required and must also have the added force of objectivity, since observer and subject are joint and independently situated witnesses of the necessity of the relations and their markers (Strawson, 1959; Bruner, 1973). Thus to analyse the particular situation of this experiment: it is one in which speech-in-context is allowed to progress more or less closely with interleaved action (production as opposed to descriptions of relations). The two contrasted groups (MC and LWC) are all 'speakers', but to some it is quite normal to refer to relations of various kinds (MC), to others, this is a less familiar use (LWC). Clearly the

situation here is one in which the MC group are ready to operate, using speech in the mutual exchange of dialogue as a cognitive instrument. Thus pre-test and 'language training' together 'trigger' progress in further more competent production of relations seen in post-test I. The LWC have not the ready priming of descriptive usage but given some reorientation through 'language training', followed by the production of relations in post-test I are now 'triggered' for the complicated transaction of detachment and objectification of descriptions of relations. As to the pattern of 'logical' progress itself, one may be able to relate this to the influence of 'language' in at least three ways which are combined: (1) quantity at differential rates; (2) quality; (3) sequential timing. These refer to: (1) the fact that there was appreciably more progress in all cases where dialogue had intervened, bearing in mind also that on selection at equal seriation levels the MC group were younger than the LWC though they were more advanced in descriptions. The 'interaction hypothesis' is then forced upon one by the prompt response in 'logic' of subjects ready with descriptions; (2) results suggest that precise qualitative levels of 'descriptive readiness' may relate directly to concomitant levels in 'logic'. The bulk of progress in seriation was a matter of ordinal assembly of rods based on perceptual cues and strategies. This coincided with descriptive readiness in the reversible use of 'bigger/smaller'. Then, at the final point of change, the adoption of 'logical' ('double-comparison') strategies occurred among subjects who were ready with the apposite 'three element' description; (3) the necessary ingredients for interaction appear to include the sequential timing of descriptive readiness with logical production where one precedes or follows the other. One has then a possible 'triggering' of 'language' and 'logic' interaction where quality of reference is precisely primed.

These findings, thus interpreted, do not contradict the language facilitation model of Piaget; rather they go further, in that they stress and elaborate the influence of speech. Likewise, Bruner's original suggestion that language can be an instrument of a social influence is endorsed. Indeed Bruner's more recent opinion admits the 'cognition hypothesis' of language acquisition which derives from Piaget (Cromer, 1974), whilst retaining his original stress on the importance of social linguistic influence in cognitive development (Bruner, 1975). At least at the period of early and prelinguistic acquisition, current trends of thought lean towards some form of interaction of speech and cognition

where speech is analysed by function (Macnamara, 1972; Ryan, 1974; Cromer, 1974; Bruner, 1973). Such a relationship may be fairly obvious in early ontogeny but the present findings provide suggestive evidence consonant with a similar theoretical position at a later period of development, with some specific indication of necessary components and their relative timing in the interaction concerned. Furthermore, according to Piaget's scheme of emerging 'logic', it appears that the child passes through a period of perceptually dominated strategies and judgements but it is not clear how the transition to logical understanding occurs. In this experiment we have information relating timing and sequence of progress in 'logic' and the related descriptions which provide the intriguing, if tentative, possibility that at the final point of descriptive precision (three elements), speech in dialogue form may free the 'logical' strategies from their perceptual basis in the ongoing process of organization and production of asymmetrical size order relations (Piaget, 1950).

In order to continue the main line of enquiry of this project in the studies which follow it is intended to consider more precisely the exact nature of the interactive process occurring between speech and the growth of understanding of seriation in the child. As discussed above it may well be that some aspect of the communication between the observer and child enables the child to realize his own formulations while at the same time extending his conception of the serial relations towards an objective viewpoint. These aspects of the process seem to rest in the dialogue between the observer and child. Investigation 2 to be described in the next chapter attempts to test the central influence of this dialogue.

Chapter 3

COMPARISONS OF THE EFFECTS OF DIFFERENT SPEECH CONDITIONS ON PROGRESS IN SERIATION

In the first investigation significant progress in seriation was effected by discussion between the observer and the child; discussion about the differences in an asymmetrical size series. The observer elicited descriptions and explanations of these differences from the child as she demonstrated them to him. This dialogue was the context in which the child learned to provide appropriate descriptions both for the relations of elements in ascending and descending order and eventually for each individual element in relation to those on either side of it. Results showed clearly that such intervention produced significant progress in seriation. However the observer's intervention was complex and this leaves open the question as to which components are effective. As discussed previously one of the salient features of the dialogue is its communicative function in which participants must operate in relation to each other's point of view. It is also in the nature of such discussion that participants must formulate their own responses. These aspects of the intervention were thought to be a central influence on the seriation progress made. But the syntactic features of the descriptions being learned could have had a didactic shaping effect upon the child's thinking about serial relations and even though the child did not himself arrange the elements in series, implicit actions could have been the effective agent of change. The aim of investigation 2 was to compare the effects upon progress in seriation of three separate intervention conditions which isolate these three aspects of speech, namely:

1) discussion about serial relations between observer and child (dialogue condition);
2) the child ordering elements in series without relevant discussion or related descriptions (action condition);
3) the child learning the appropriate descriptions of relations while he watches the observer order serial relations (didactic condition).

A simplistic interpretation of the theories of Piaget and Bruner may lead one to predict the effectiveness of the last two conditions mentioned; the didactic condition and the action condition. Indeed Bruner's theory of the role of speech in cognitive development as he

propounded it in 1964 and 1966 does suggest that speech forms operate like a lattice or grid instrumental to the construction of evolving thought systems (cf. p.7 chapter 1). Speech then is a socially shaping influence upon the individual and from this, one step further in the argument predicts that to learn the appropriate forms by direct imitation will be the most efficient means of expediting the development of the particular sphere of understanding in the child. This appears to be the kind of reasoning behind the didactic language rehabilitation programme of Bereiter and Engelmann (1966). However these assumptions fail to take account of the process whereby the speech forms being learned may relate to evolving understanding in the child. There is a gap in explanation between the syntactic and semantic speech functioning. In other words, such an argument makes no attempt to account for the way speech operates in context. This may seem to be a curious omission if one considers the idea that most naturally speech evolves as it functions in the life of the child. Indeed Bruner (1975) now suggests how to fill this gap by saying 'that what the child learns about communication, before language, helps him crack the linguistic code. For communication is converted into speech through a series of procedural advances that are achieved in highly familiar, well learned contexts that have already undergone conventionalization at the hands of the infant and his mother (or caretaker).' But one may rebut this by pointing out the 'automatic' acquisitions of speech forms which were noted but dismissed by Sinclair-de-Zwart (cf. p.26 chapter 2). Indeed it was clear from findings of investigation 1 of this project that the children already able to use appropriate descriptions, perhaps in some automatic sense, promptly benefited by the practice in their use. Perhaps they had learned these forms partly through imitation or direct teaching by their parents. There may indeed be a case for arguing that training in the use of speech forms is a direct route to clear understanding of the logical relations concerned. This of course assumes a very strong role for speech in cognitive development. The other extreme is to take Piaget literally. He stresses the idea that logical understanding evolves from the child's earliest practical activities (Piaget, 1970a). But this, more fundamentally is his theory of self-regulation. It is not just action in a physical sense but the fact that the action of the child is self-determined which enables the child to realise new cognitive structures. Admittedly the child of 6 or 7 may sometimes talk about the problems he is resolving, but Piaget (1970a) lays the full onus on the

child's self-regulated activity for the development of his understanding. The difficulty is that serial relations are in fact abstract; they do not exist in individual elements, nor are they entirely to be epitomized in a visually perceived configuration. This is so particularly for the double relation of each element to its neighbours. Most efficiently it is formulated in the 'description of three elements' (cf. p.29 chapter 2). Thus although it may seem reasonable to assume that Piaget's theory would regard the 'action' condition as most effective in producing progress in seriation this may be an oversimplification of Piaget's meaning. It is perhaps wiser to temper this idea by remembering that for Piaget 'action' is an synonym for self-regulation and that at the transition to 'operational' levels of thought Piaget refers to 'internalised action'. In order to internalise and store a configuration whose generality depends upon a set of relations some mediating representational system is surely required. Indeed Piaget believes that the early sensori-motor understanding is gradually reconstructed on a representational plane once the 'semiotic processes' become available to the child (cf. p.16 chapter 1). Moreover as regards the process by which this occurs Piaget does not dismiss the influence of social transactions (Piaget, 1950. cf. p.67 chapter 4). These would include discussion with adults although Piaget appears to stress thé possible effects of arguments with peers. However Piaget has not recently emphasized the possible role of dialogue in cognitive development in the sense that it may be the means of expediting the growth of an objective viewpoint, nor does he elaborate its obvious advantages for realising self-regulative processes in speech. Bruner (1973, 1975) has recently begun to trace the evolution of speech in action and has expressed particular interest in the dialogue between mother and child as a possible means by which the child gains an understanding of deixis (using speech forms appropriately to express reciprocal viewpoints). He thinks that this may explain how speech is gradually detached from its specific action context.

Discussion of results of investigation 1 (chapter 2) led to the view that just these aspects of dialogue may be the impelling force which produced progress in seriation. Moreover dialogue seems to be the most natural speech mode if it is to function in context of resolving and formulating serial relations. Thus investigation 2 was undertaken in order to test this prediction by contrasting the influence of dialogue between the observer and child with that of an 'action' condition and a 'didactic' condition upon progress in seriation.

Rationale which determined the selection of subjects and type of intervention tasks for investigation 2.

Results of investigation 1 seemed to show that the effect upon progress in seriation of learning descriptions was very specific. For instance children who had just learned to use the terms 'bigger/ smaller' appropriately but who were not yet well versed in the 'three element description' progressed in the construction of the 'loose sets' but made little progress in inserting an extra rod in the 'covered sets'. The few data available of those children already able to describe the relation of three elements suggested that these children were ready to make progress in the 'covered sets' tasks. In fact it was clear that where children already possessed an appropriate means of description (MC group) they could respond promptly to practice in this use by showing immediate progress in the apposite seriation tasks. It therefore seemed that the subjects most likely to show the kind of progress to be studied in investigation 2 would be 'intuitive' seriators who should as far as possible be able to describe the relations of three elements. These children would most appropriately require to be given an insertion task for the intervention procedure and selection, and post-testing in seriation would be confined to the 'covered sets' problem. Obviously the insertion task for intervention should be perceptually different from the 'covered sets' tasks and there would be no need for such a task to involve covering the elements to be used.

METHOD

Design

Four matched groups of ten children were selected at pretest sessions. They were given three intervention sessions on consecutive days and two post-tests, the first one day after intervention, the second two weeks later. All sessions were individual. All sessions were video recorded.

Subjects

Subjects were drawn from three schools within a two mile radius of each other in Southampton. All three schools use similar child-centred methods. The intake of one school is predominantly from clerical or professional homes, the other two have a mixed social class intake. Children were pretested who were between 5 and 6 years and who had no

known physical, social or emotional handicaps. Their home background ranged from upper working class to professional. They were taken in alphabetical order. The children who were selected at pretest were those able to construct 'loose-sets' by trial and error but who did not make systematic double-comparisons on the 'covered sets' tasks. For this study they were classified as 'intermediate' seriators. Those selected were also required to be able to describe three elements appropriately with or without prompts. Children who did not conform to these criteria were dropped after the pretest. Those who did were allocated in alphabetical order to four groups designed A, B, C, D. These labels referred to the type of intervention condition the groups were given. Group A were given the 'action' condition, group B the 'dialogue' condition, group C the 'didactic' condition and group D which was the control group did not have any intervention between pre- and post-testing. The groups were composed as far as possible of equal numbers of boys and girls. Their mean chronological ages were: group A 5•7, group B 5•6, group C 5•7, group D 5•7 years respectively.

Materials

1) For testing seriation materials were as described in investigation 1.

2) For the intervention problem two sets of flat discs were used (circles and squares). Items in the sets differed in size by very small amounts as will be seen by the measurements given below. The set of circles was used to demonstrate the task, the set of squares for the child to resolve the insertion problem itself. The shapes were cut out of coloured formica and backed with sand-paper. The demonstration set of circles comprised two red discs 7 cms and 4 cms in diameter respectively and four yellow discs 8 cms, 6 cms, 5•7 cms and 2•5 cms. The red discs were end-items between which others could or could not be placed if serial size order was to be maintained. The set of square discs used for the problem were two yellow items 8•4 cms and 5 cms square respectively. These were the end-items which were placed on a board, and there were nine blue square discs which were hidden in a cloth bag. These items each respectively measured 9•8 cms, 9•4 cms, 9 cms, 8 cms, 7•3 cms, 6•4 cms, 4•4 cms, 2•4 cms and 1•4 cms square.

There were two three-ply wooden boards covered with blue and beige brushed nylon respectively, measuring 38 by 58 cms. On these shapes were placed. The sand-paper backing of the discs adhered to the nylon thus holding items in position.

3) For recording data, video tape recording equipment consisted in a Sony Video Rover pack and tripod.

Procedures

General arrangement

The schools provided a separate room for the individual sessions. With minor variations general arrangements for all sessions were as follows: The child sat at a small table about five feet away from and facing the camera which was set on a tripod. The tape deck and power pack were on a trolley beside the camera.

The observer sat beside and partly facing the child to his left between him and the camera where she could reach apparatus for his use set on a table to her right and also the starter button of the camera behind and to her left. She was, of course out of the camera's view.

Each session was introduced as the child entered the room with the observer, by her indicating the camera, apparatus and table at which the child was to sit. The observer explained that he would be playing some games with her and that the camera would take some pictures 'rather like the Tele' and that afterwards he might see some of the pictures. Then the child sat at the table while the camera was focussed. The observer then moved to her seated position by the child's table when the session would begin. Once the child's attention was taken up with the seriation problems the camera was forgotten and the observer was able to operate the camera starter button and also take notes on her knee without distracting him.

At the end of each session each child was invited to see 'his picture'. This was played back to him for a few seconds in the camera. The child regarded this as a treat, it enabled the observer to check the quality of recording and it seemed ethically sound to give him this opportunity.

In order to obtain a good video recording of the child doing the seriation and intervention tasks and to ensure at the same time a good view of materials by the child himself, materials were set out as follows: One of the plywood boards was placed on the table in front of the child tilted very slightly towards the camera by means of a thin block placed under it. On the board items for the tasks were placed and the height of the child's chair or the block were suitably adjusted in order that each child should see his work clearly.

Seriation procedures

These were the same as those used in investigation 1. As previously the demonstration yellow loose-set was shown to the child already assembled and he was asked to describe the relations of elements in ascending and descending order and to describe the central item of three. However, only one loose-set had to be constructed here and only the completed task and not the process of assembly were video recorded. All three covered-sets tasks were always done by the child and fully recorded. The observer noted the child's description of the loose-set and kept short-hand notes of comparisons made in the covered-sets as a precautionary check on video tape records.

Intervention procedures

The basic procedure was the same for all three conditions of intervention. These will first be described and then there will be an account of features specific to each condition. In all conditions children arrived at correct solutions with a minimum of prompting from the observer. The general procedure was:

a) demonstration: Four of the circular discs were assembled in order of size horizontally across one of the boards with the two red discs at either end. In addition the smallest and largest yellow discs which were respectively too small and too large to be placed between the red discs in the serial arrangement were placed each at the appropriate end but below the line of items. The child was asked to describe the size relations of the discs and to consider why the intermediate sized yellow discs were appropriately placed between the end red ones e.g. 'because they are smaller than the big red circle and bigger than the small red one'. The reason why the remaining yellow discs were excluded was also established e.g. 'because one is too small to go in between the red ones and the other is too big'. Children were encouraged to pick up and compare the items if they wished or to watch the observer doing so.

b) the problem: The two yellow squares were now placed a few inches apart horizontally on the second board which was put in front of the child. The arrangement of circles remained in view. The child was given the cloth bag containing the blue squares. He was told its contents and asked to draw items out of it one at a time without looking with the aim of finding squares the right size to go between the big and small end

yellow squares. Squares of the appropriate size should be placed between the end ones and any that were either too big or too small should be put aside (in a box). The child was told that he could move the yellow squares apart if he needed to make room for intermediate items. Also he was encouraged to check whether his placements were correct. The task was complete when all items from the bag had been dealt with.

At this point the observer reversed the positions of the end squares and asked the child whether squares he had placed were still in correct position. Children often felt that they had to check whether this was so. The same procedure followed for the middle three squares and was pursued until the child appreciated that the relations of the central element were not affected by the left/right positions of those on either side of it. For convenience this exercise is designated 'the reversal procedure'.

Although the intervention task is apparently mundane, for children of this level of understanding it poses an absorbing problem. Precise comparisons have to be made which seems to tap an intrinsic pleasure in making serial arrangements. The children consistently enjoyed these tasks and derived amusement from drawing items out of 'the secret bag', so called because it provided surprises. There was particular merriment when the smallest or largest squares were taken out, perhaps because for these, differences were obvious as compared to the much more difficult fine relations of other items to each other.

Specific conditions of intervention:

1) Condition A (the 'action' condition). In this condition the descriptions 'bigger and smaller' were avoided at the preliminary demonstration and the child was not asked to describe what he was doing when he did the task. Instead comparisons were made between items without discussion. In explanation of the task the observer asked the child to find items that would 'go in between' the end squares 'just like' the arrangement of circles he had before him. While the child was doing the task discussion was confined to occasional encouragement from the observer and prompts requiring the child to check whether his placements were correct e.g. 'That's nice. Do you think it is quite right? Now what will you do next?' There were one or two occasions when children placed items simply by reference to the amount of space between the end elements. This the observer would correct by reminding

the child 'we are putting them in between for size aren't we?'. She would then perhaps point to the size differences in the set of circles. As previously mentioned (p.52) children soon corrected their mistakes. In the reversal procedure afterwards relational terms were avoided by simply asking the child after the end elements had been reversed, if the middle items were still in the right place.

2) Condition B (the 'dialogue' condition). This was characterised by full discussion between the observer and the child in which the observer asked the child to describe and explain the size relationships between the elements he was placing. He was also asked to predict what these relationships should be for items which would qualify to go between end-items before he extracted them from the bag. When he had placed them he was asked to consider whether his placements were correct and why this was so. If he was incorrect he was asked to reiterate the necessary requirements; to reconsider and to correct his actions when he came to the point of recognizing that there was a need to do so. Since the task involved inserting items between the end elements of an ordinal series most of the critical explanations required of the child consisted in describing the double and reversed relationship of a middle element to its neighbours. This particular description was always found difficult even to those children who would give it spontaneously from the start. Piaget would maintain that this is because it involves a reversal of thought. In any event, if children were hesitant in their descriptions they were referred to the model and a step by step description was elicited from them by the observer. To summarise, condition B consisted in a discussion which was led and guided by the observer but formulations were always elicited from the child at the pace he seemed to require.

3) Condition C (the 'didactic' condition). This condition was designed to place the onus of teaching the appropriate descriptions on the observer. Indeed the observer herself extracted items from the bag and placed them correctly. She adjured the child to watch her actions closely and encouraged him to give the appropriate descriptions and explanations as she did so. Children enjoyed this procedure provided that it took the form of a recitation game with a rhythmical pace to it. Once learned the 'formula' was recited with relish. But children were also inclined to attempt to join in the action as well as the description. This was avoided by the observer concentrating on her own actions and their description.

ANALYSIS OF DATA

Recording and transcription

In study 2 and all those which followed data were video recorded. This seemed a suitable technique where the close liaison of speech and action was being considered. In study 1 speech was sound recorded and the observer herself noted the child's actions and since results suggested that speech and action were closely related video recording was subsequently adopted. The sound records of the speech in study 1 were transcribed in type script in order to provide a more durable record than the tape. This also facilitated analysis of the data once categories had been decided upon from a scrutiny of the tapes themselves. The same procedure was followed with the video records and here in order to gain a clear impression of speech and action in parallel these were described in opposite columns of the typed transcription; the speech on the left, the actions described on the right. The child's speech and actions were typed in upper case script, those of the observer in lower case. Short examples of these transcriptions are given in Appendix III (p.167).

Analysis of the seriation tasks:

In study 2 the seriation behaviour selected for observation was restricted to that regarded as typical of 'intuitive' levels of understanding by Piaget (cf. p. 49 chapter 3) whereas in study 1 'preoperational' levels were also being considered. According to Piaget the 'preoperational' child typically does not appreciate the general nature of relations in a series and is satisfied if he distributes different sized rods in size categories e.g. 'big', 'little'. The 'intuitive' seriator is not satisfied with an incorrect serial arrangement; he organises 'loose-sets' correctly by trial and error, i.e. he appreciates when errors occur and can remedy them. However although this capability appears to indicate that he realises the general nature of ascending and descending size relations in the serial configuration and that the same relations occur in reversed orientation, 'intuitive' subjects are typically unable to insert extra rods in a series using a systematic logical strategy. Subjects capable of such behaviour are regarded as 'operational' seriators by Piaget. In this project the best criterion of this level of understanding has been taken as the systematic use of 'double comparison' strategies in the

'covered-sets' tasks (cf. pp.34,35, chapter 2). Here, with the aid of the video recordings it was possible to itemise in detail the actions of children selected at pretest and the ways in which their later behaviour at post-tests differed from their initial covered-set strategies.

Pretest covered-set behaviour:

As before mentioned (p.50) children selected at pretest could construct loose-sets correctly by trial and error and were able to describe the relations of a series, including the three element description with prompts. In addition the following characteristics of their covered-set behaviour were noted:

All subjects made comparisons of the insertion rod ('i') with rods in the series any one of which is represented as C. The ten rods from the smallest to the largest are numbered 1 - 10. The various comparison strategies were:

a) children frequently compared 'i' with one or both end elements. If the orientation was not the same as in the previous set they expressed surprise. Thus although both left and right orientations of bigger/smaller were appreciated by the children there seemed to be a tendency to assume one or the other. Children who did not check end elements appeared to be acting on such an assumption and were sometimes confused by the sequence of relations which emerged. Checking the second end element often seemed to be an afterthought when the first gave an unexpected result.

b) some children made spot checks of both end elements. Then they would compare 'i' with one or two items in the set and place it next to one which seemed close to it in size.

c) most frequently children made a sequence of comparisons in either ascending or descending size order. In this case if 'i' was held to the right of C for ascending order of change, or vice versa, direct placement gave a correct result when the difference between 'i' and C became relatively small. Of course this depended upon the child having judged the correct amount of difference between elements in the set and assumed it to be an even amount otherwise the result would not be correct. However some children held 'i' to the left of C when comparing a sequence of ascending size relations, or the reverse. Thus unless 'i' and C were transposed before 'i' was finally placed its position would be wrong unless the child had passed the point where relations of

'i' and C had changed. Some children managed this transposition, some went past the point of changed relation.

d) some children compared 'i' with all ten items in the series. What they did after this varied. A few of them repeated this until the observer pressed them to decide where 'i' should be placed. Such children would finally place 'i' by some approximation of the whole sequence of size relations they had seen to the size of 'i'. Others made a direct decision about where to place 'i' and did so. None of these children repeated the comparisons on both sides of the point chosen. This would have been regarded as a 'double-comparison'.

To summarise and interpret the behaviour of subjects selected at pretest, they appeared to have the appropriate repertoire of skills to enable them to judge the need for making double-comparisons in order to insert 'i' correctly in the covered sets but in order to do this they would need to appreciate the necessary coordination of relations in a series. The strategies used suggested that these children were seeking a particular amount of difference in one direction only between 'i' and C.

Post-test covered-set behaviour:

It is the synthesis of skills as the child comes to appreciate essential relations of a series which appears to be emerging as the 'intuitive' child becomes 'operational' and which systematic use of the double-comparison strategy is thought to reveal. The child who repeatedly uses this strategy appears to be seeking the point where 'i' bears opposite relations to items on either side of it. As the child comes to realise this new goal he must organise strategies accordingly; he must become flexible in using left/right positioning of 'i' and C; he must bear in mind the reversible orientations of series; then he must focus on the reversed relationship of 'i' to Cs on either side of it and concentrate sufficiently to make precise comparisons with each appropriate item if he is to insert 'i' correctly using the double-comparison strategy. Indeed he may be attempting to use the idea of reversed relationship which for lack of skill he cannot at first effect. On the other hand, the gamut of strategies employed at pretest make it feasible for a child to use a double-comparison fortuitously in the course of seeking a small difference between 'i' and C on one side only. In the event no children were selected who used clear though isolated double-comparisons at pretest.

Differences in behaviour at post-test in the covered-sets were categorized into three types (I, II and III). Within each of these there was variety. Responses were scored on the basis of achievement and consistency for the three covered-set tasks at each post-test.

Achievement: levels of competence in covered-sets tasks:

Level I was characterised by any of the strategies described above for pretest covered-set behaviour;

Level II were double-comparisons which were partly effective. The following instances appear to indicate that children who are just beginning to grasp the new idea of reversed relations of 'i' to elements on each side of it at the point of its placement have difficulty in marshalling the skills required to put the idea into effect:

a) the child appears to aim for a double-comparison but misses the position of the second, thus, where 'i' should be placed between 3 and 4 the child compares it with 1, 2, 3 and 5 and then inserts 'i' correctly. This behaviour occurred when the child, seemingly eager to put a new idea into effect, acted hastily;

b) the child made some extra comparisons beyond the point at which the relationsof 'i' with C changed, then placed 'i' correctly (no more than 3 extra comparisons);

c) the child, about to place 'i' after only one comparison immediately rectified this when asked in the usual way (cf. p.33 chapter 2) if he was sure that he had made enough comparisons to be certain of placing 'i' correctly;

d) the child misjudged the exact place to insert 'i' when making a rapid sequence of comparisons ending in a double-comparison.

Level III were clear double-comparisons followed by appropriate placement of 'i'. Most of the behaviour in this category consisted in the child making a rapid sequence of comparisons in order of size followed by deliberate double checking of elements on each side of the point of placement. Included here are children who made a complete run of comparisons of all ten elements in the series but who stopped at the point of changed relationship to 'i' and drew out a rod to mark the position. They afterwards placed 'i' correctly at this point.

Scoring

The scoring is depicted in Table I below. It was based on achievement at levels I, II and III and consistency across the three covered-set tasks at post-tests I and II. Isolated instances of double comparisons were not scored above pretest level I.

Table I.

Tasks			Score
1	2	3	
I	I	I	1
II	I	I	1
III	I	I	1
II	II	I	2
II	II	II	3
III	II	I	4
III	II	II	5
III	III	I	6
III	III	II	7
III	III	III	8

TREATMENT OF RESULTS

Table 2 (p.61) provides a summary of all the scores.

This experiment consisted in a two by four design where four conditions of intervention and two post-tests for each intervention group were the comparisons which were of interest, based on achievement in the covered-sets tasks. These comparisons could be made using a repeated measures analysis of variance provided that the score distribution could be regarded as normal. In fact results appeared to show a quite marked floor-effect such that 27 of the 40 subjects (67.5%) did not improve on their pretest covered-set behaviour. Thus a test for the homogeneity of data was made and gave a highly significant result (F Max 2.79^2/ F Min $0.30^2 = 86.49$ $p < .01$). Since the basic requirement for the use of parametric tests by analysis of variance was not met non-parametric statistics were used instead. For comparisons between post-tests I and II the Wilcoxon matched-pairs signed-ranks test was used. To compare achievement between the four groups the Kruskal-Wallis one-way analysis of variance was used and the Mann Whitney U test was employed to make comparisons between specific groups.

RESULTS

The comparison of scores between post-tests I and II for each group using the Wilcoxon matched-pairs signed-ranks tests was not significant (A T=1.5 N=3 n.s.; B T=6.5 N=8 n.s.; C T=1 N=2 n.s.; D T=0 N=0 n.s.). Based on this finding scores at the two post-tests for each group respectively were combined for all subsequent tests. (Post-tests I and II were separated by two weeks).

Comparison of achievement on the combined post-tests between the four groups using the Kruskal-Wallis one-way analysis of variance proved significant ($H=10.63$ $df=3$ $N=10$ $p<.01$).

Inspection of Table 2 (p.61) shows that in group B only two of the ten subjects did not score above pretest level in the post-tests, none did so of the control group D, three out of ten in group A and two out of ten in group C. Thus of the four conditions only B appeared to differ from pretest levels appreciably. A comparison of individual conditions using the Mann-Whitney U test confirmed that this was so (B/A $U=27$ $N=10$ $p<.05$; B/C $U=17$ $N=10$ $p<.01$; B/D $U=10$ $p<.001$). All other comparisons between groups proved not to be significant (A/D $U=38.5$ $N=10$ n.s.; A/C $U=46.5$ $N=10$ n.s.; D/C $U=40$ $N=10$ n.s.). All the significance levels quoted are two-tailed.

To summarise these findings:

1) The two post-test scores did not differ significantly from each other within any of the groups thus for later comparisons between groups scores for both were combined.

2) An overall comparison of achievement at post-test in the four groups showed significant differences.

3) Inspection of results in Table 2 (p.62) and individual comparisons between groups showed that group B which had the 'dialogue' condition was responsible for this difference.

Table 2

Levels of achievement in tasks 1,2,3 and scores at Post-tests I and II for subjects in groups A,B,C,D.

Group A

	Post-test I				Post-test II				Post-tests I & II
	Tasks			Score	Tasks			Score	Total
Subjects	1	2	3		1	2	3		
1	III	I	I	1	I	III	I	1	2
2	I	I	I	1	I	I	I	1	2
3	III	I	I	1	III	III	III	8	9
4	I	I	I	1	III	III	I	6	7
5	I	I	I	1	I	I	I	1	2
6	I	I	I	1	I	I	I	1	2
7	I	I	I	1	I	I	I	1	2
8	III	I	III	6	I	I	III	1	7
9	I	I	I	1	I	I	I	1	2
10	I	I	I	1	I	I	I	1	2

Group B

	Post-test I				Post-test II			
	Tasks			Score	Tasks			Score	
Subjects	1	2	3		1	2	3		
1	I	I	I	1	I	I	II	1	2
2	I	III	I	1	III	III	II	8	9
3	II	II	I	2	I	II	III	6	8
4	I	I	I	1	I	III	II	5	6
5	I	I	I	1	I	II	II	3	4
6	III	III	III	8	III	I	I	1	9
7	I	I	I	1	I	I	I	1	2
8	II	I	I	1	III	III	III	8	9
9	III	II	I	4	III	III	II	7	11
10	I	I	I	1	III	III	I	6	7

Group C

	Post-test I				Post-test II			
	Tasks			Score	Tasks			Score	
Subjects	1	2	3		1	2	3		
1	I	I	I	1	I	I	I	1	2
2	I	I	I	1	I	I	I	1	2
3	I	I	I	1	I	I	I	1	2
4	I	I	I	1	I	I	I	1	2
5	II	I	I	1	I	I	I	1	2
6	II	I	I	1	II	I	I	1	2
7	I	I	I	1	I	I	I	1	2
8	I	I	I	1	III	I	III	6	7
9	I	I	I	1	I	I	I	1	2
10	I	III	II	4	I	I	I	1	5

Group D

	Post-test I				Post-test II			
	Tasks			Score	Tasks			Score	
Subjects	1	2	3		1	2	3		
1	I	I	I	1	I	I	I	1	2
2	I	I	I	1	I	I	I	1	2
3	I	I	I	1	I	I	I	1	2
4	I	I	I	1	I	I	I	1	2
5	I	I	I	1	I	I	I	1	2
6	I	I	I	1	I	I	I	1	2
7	I	I	I	1	I	I	I	1	2
8	I	I	I	1	I	I	I	1	2
9	I	I	I	1	I	I	I	1	2
10	I	I	I	1	I	I	I	1	2

DISCUSSION

Before discussing the implications of the main findings of this study there will be a brief consideration of the nature of cognitive development observed here. Present findings suggest that the 'intuitive' child's developing grasp of serial relations is subtle and perhaps fleeting. It is not easy to observe. Inhelder, Sinclair and Bovet (1974) have noted this when studying directed learning in various cognitive domains. Their study will be described in more detail in chapter 5. The main point here is their confirmation that children seem to advance in understanding by small almost imperceptible degrees which are not consistently maintained. In relation to the discussion here to follow it is interesting that the clear progress made by their subjects was always accompanied by a dialogue with the observer, a point which seems to be overlooked by them. In the present study the video recordings made possible observations of behaviour across a fine threshold of change where the three element description referred precisely to behaviour in the covered-set insertion task. A repertoire of skills was itemized that characterised pretest behaviour. Their appropriate synthesis towards the most effective strategy for inserting elements in the covered-sets appeared here and there among children who had the 'action' and 'didactic' conditions of intervention but much more systematically among children who had discussed the intervention task with the observer. Although Group B subjects did not maintain this level of operation consistently they did so sufficiently often to suggest that understanding of the dual relations of 'i' to its neighbours was emerging as being essential to the constitution of a series.

The results of comparisons of achievement in the post-test covered-set seriation tasks are remarkably clear. The overall comparisons showed there was a significant difference between the groups which individual comparisons and scrutiny of results showed to be due to the responses of group B subjects. Only two of the ten subjects in this group were not behaving in advance of pretest. Group B differed from the 'action' group at a .05% level of significance, from the 'didactic' group at a .01% level and from the control group at a .001% level. It is not possible to judge whether these degrees of difference represent the amount of influence each condition respectively may have

upon cognitive progress; whether in fact an 'action' condition is more useful than a 'didactic' one and that each of these is better than no intervention at all. Certainly such an idea is plausible but present results do not justify any assertions about the relative influence of different conditions. On the other hand they do confirm the prediction that dialogue is a significantly effective influence upon cognitive advance. The experiments of Bruner et.al (1964, 1966) are based on the idea that separate components may individually influence cognitive growth (cf. pp. 9, 10 and 11, chapter 1). In particular Sonstroem's comparisons of conditions where 'manipulation' and 'labelling' are contrasted seem to make this assumption but she did find that a combination of these two conditions was more effective than their individual influence. If one pursues the separate component idea it could be argued that the memory load required to combine the necessary relations of a series is carried better if manipulation (action) is explicitly 'labelled' and thus categorised. In these terms the present 'dialogue' would be no more than such a mnemonic device. The 'didactic' condition would be less useful because although labels are provided their apposite categorization could only occur later. Perhaps something like this did happen in the previous study 1 where the MC children already able to describe relations, nevertheless benefited by experience in their use. However, it is when one considers in more detail the possible processes at work in dialogue that these suppositions seem to be only part of the story. They may in fact be better explained as features of quite another story. The main characteristics of the dialogue in this study were: that speech was essentially related to specific context, that of ongoing problem solution concerned with serial relations; that speech was necessarily a reciprocal formulation of these relations in terms of the listener's point of view; and that by virtue of this ongoing contextual reference both to the problem and to the other person it had to be apposite, objective and spontaneous. In fact such dialogue serves processes now being emphasized both by Piaget and Bruner, namely Piaget's process of self-regulation, and the deictic detachment discussed by Bruner (1975). The notion of separate component influences seems to fall short of the required explanation. In fact the present author is inclined to suspect that dialogue has so strong an influence because it is incorporated into the problem solving process itself; the process of cognitive growth. It is hoped to

elaborate this idea in the final chapter.

Study 2 here has concentrated attention on dialogue as opposed to other speech intervention conditions. It now remains to consider the exact nature of this dialogue which appears so effective. Until this is done the processes suggested above as being responsible for the cognitive effect remain conjectural.

Chapter 4

THE EFFECTIVE FEATURES OF RECIPROCITY IN DIALOGUE

The aim of the next study (3) is concerned with the analysis of the dialogue which has proved effective in producing progress in seriation. The social interaction which is an essential underlying feature of dialogue may be the process which combines speech and action effectively, for neither of these components were independently productive of cognitive change. But social interactive processes are complex and it is not clear what particular characteristics may be operative here.

The dialogue of condition B in study 2 consisted in a discussion between the observer and the child. The observer led the discussion by asking the child questions designed to elicit from him a precisely appropriate description of the size relations necessary to the insertion task. For instance, a shape that would go between the end elements must be bigger than one and smaller than the other. It must relate in opposite fashion to the elements on either side of it and this involved giving the description of three elements. This coordinated description of relations has always proved to be more difficult to formulate than two or more relations of the same kind as each other e.g. 'smaller, smaller' or the reverse sequence. But even if the child were unable at first to give the three element description in this dialogue the observer did not then describe it for him. Instead she led him gradually to a point where he was himself able to combine opposite one-way descriptions; the observer adapted her questions to suit individual needs so that each child was able to arrive at his own formulation of the appropriate descriptions. Thus it is clear that reciprocal roles in this dialogue are not equally balanced. Instead they are asymmetrical, for the observer has command of the nature of the task and can also appreciate the child's view of it. This gives her the freedom to guide the child towards the end she has in view. In contrast the child's viewpoint is narrowly restricted by his ignorance of the task and because he is confined to his own view of it. The possible importance of these features of the discussion will be considered later, but it may be pertinent at first to ask whether these are characteristic of everyday life and are the natural manifestation of social and cognitive ontogenetic processes.

Certainly this kind of dialogue may well be seen as an advanced stage of a continuum which originates with the communicative exchanges

set up between mother and child from birth onwards. This view of the matter has been promulgated by Ryan (1974) drawing upon Piaget (1962), Austin (1962), Strawson (1964) and others. As discussed in the previous chapter (p.47) Bruner's more recent work (1973, 1975) makes this assumption at least in so far as he sees speech arising in the social transactions of mother and child. Richards (1976) quotes the unpublished work of Ringler which suggests that disruption of the earliest mother-child relationships may have long-term effects on their mutual speech at preschool age. There is some suggestive confirmation of this in the differential effects of characteristic social control systems (Bernstein 1973, Robinson and Rackstraw 1972) which may indicate the same kind of continuity. Also in line with these findings the author (Heber 1974) found semantic and syntactic differences in the use of questions by lower working class and middle class boys of seven. The present study (1) of this project has linked such differences in speech usage with the degree of understanding seriation (p.44). It is possible that a relatively stereotyped use of questions reflects the lack of reasoned discussion between lower working class mothers and their children which in turn may arise out of characteristic features of social interaction within such groups. However, differences in speech usage are only pertinent here if they throw light on the processes at work. There is indeed at least suggestive evidence that the earliest social control systems have continuity with their later manifestations in speech, in dialogue in particular. But if mother and baby originate this process it must be essentially asymmetrical because of the baby's inexperience. In this way dialogue in the present study is similar to it. Although many of the social exchanges could be instigated and led by the baby this could only be achieved because the mother is more adaptable. The mother is more often likely to be the innovator since she has so much more experience and cognitive flexibility than the infant. Above all, just as in the present dialogue, she will be able to take the child's viewpoint and adjust herself to the pace that he requires for assimilating new experience. These are exactly the characteristics of the present dialogue of observer and child.

Ryan (1974) and Bruner (1975) are both attempting to account for the development of speech by studying how it emerges out of the context of the child's earliest social interactions. This close study

of how the mother and child interact and communicate seems to be very much to the point here because the routines they are evolving together are always enlarging the child's understanding of the situations he encounters. Moreover this approach prevents the theorist from making crude assumptions about the independent effects of either action or speech. It is a pragmatic solution to fill the gap in argument discussed in the previous chapter (p.47). Bruner summarises this point when he says:

> I find that neither the syntatic nor the semantic approach to language acquisition takes sufficiently into account what the child is trying to do by communicating.... The brunt of my argument has been that one cannot understand the transition from prelinguistic to linguistic communication without taking into account the uses of communication as speech acts. (Bruner 1975, p.23).

Ryan is at pains to give Piaget the credit for explaining in detail how speech and action emerge together in the service of 'accommodative imitation' (Piaget 1962). She says 'Piaget (1946) is the only psychologist so far to have shown a sustained interest in the non-verbal pre-requisites for the beginnings of language,' (Ryan 1974 p.190) but she notes that 'Piaget sees language as simply one facet of cognitive development, providing an economical means of representing reality'.(ibid p.191) Piaget's account of the matter is focussed on the way in which the child uses individual 'symbols' (Piaget's usage) or expressions as intermediaries towards the formation of concepts, 'They are still intermediary between the individual symbol or imitative image and the sign which is properly social' (Piaget 1962, p.220). Gradually the social sign system comes to represent for the child conventional concepts. But Piaget's account is mainly concerned with how the child himself, through his own activities, uses speech to represent his developing understanding of the world of objects and events. He sees the child as '<u>self-regulator</u>' operating on his environment. Speech stems <u>from</u> this basis. Its mediation of social influences is not of primary interest to Piaget although he does consider them (Piaget 1950). He suggests that communicative systems grow up in the service of the individual's self-regulating processes. But Piaget does point out that logic requires common rules 'it is a morality of thinking imposed and sanctioned by others' (ibid p.163). He admits that the child 'first seeks to avoid contradicting himself when he is in the presence of others' (ibid p.163). He then poses the question whether

cooperation between individuals instigates the logical coordination of ideas in thought or the reverse. Notably he concludes that both are subordinate to laws of equilibrium. It is therefore the child's self-regulating processes which are the basis of cognitive growth. For Piaget the basic equilibration process produces the same kind of reactions to social experience as to experience with objects and events; disparities between present expectations (schemata) and experience of any kind produces accommodation always provided that these discrepancies lie within the range of the child's existing schemata. It is this equilibration process which Piaget most stresses in his recent writings (1970a)as being basic to all others. He concludes (Piaget 1970a, p.726), 'It is not therefore an exaggeration to say that equilibration is the fundamental factor of development, and that it is even necessary for the coordination of the three other factors', namely maturation, experience and social environment. Bearing this in mind Piaget appears to have two ways of explaining the possible efficacy of dialogue in cognitive development: the first is related to the equilibration process just described and which is uppermost in his recent writings; the second is the picture of the egocentric child whose view of the world and himself gradually 'decentres'; as the child becomes more objective, so he becomes more rational. It is in terms of this explanation that Piaget considered the nature of dialogue itself (Piaget 1926/59, p.65). Children's disagreements he suggested first make them feel the need for making themselves understood. This realisation of another's point of view he thinks may be instigated by children's quarrels but these are not in any sense real arguments. Such reasoning occurs only when the child has reached sufficient rational understanding to be able to reason a case. Both the 'decentration' account and that of 'equilibration' seem to lead to the idea that if dialogue is to affect cognitive development it will do so by making the child aware of other viewpoints; dissonance will effect reorganisation. If there is an effective influence of dialogue on cognitive development this would stem from reciprocity of equals and not from the informed guidance of one member of the dyad upon the other. But it has become clear that equal reciprocity is only one aspect of the dialogue in the present study. Here the flexible 'guidance' given to the child by the observer enables him to adapt. Piaget does not distinguish different types of dialogue in terms of their likely influence upon cognitive growth. If he had, then dialogue which allows for reciprocal adaptability would surely

seem particularly suited for the accommodating needs of young children over and above the decentering effects of differing viewpoints. These reasons combined would discriminate between symmetrical and asymmetrical dialogue effects. These two possible effects have not been differentiated by Piaget, or indeed by others in the Genevan group so far.

Light (1974) has drawn attention to this distinction in his study of role-taking in four year old children. He develops this from the theory of G. H. Mead (1934). It is perhaps reasonable to regard role-taking as part of the pre-requisite skill in communication which is later manifested in dialogue. For Mead dialogue consists in what he terms 'spoken gesture', that is, spoken discussion emerges out of the actions individuals use whilst appreciating the evoked response these will have in another. When these gestures are represented as utterances with similarly reciprocal characteristics for the individuals concerned, he calls them 'significant symbols'; they come to have agreed and shared meaning for the dyad. But to appreciate the attitudes or responses of others to one's own attitudes, presupposes the distinction of self and others in different roles. 'The self, as that which can be an object to itself, is essentially a social structure, and arises in social experience.' (Mead 1934, p.140). This self concept permits the individual 'to converse with himself as he communicated with others'. (ibid p.140). The full appreciation of points of view in general Mead refers to as the 'generalized other' and most pertinent to present argument, he differentiates within this, abstract communities of attitudes. The most important here is that of 'significant symbols', 'the logical universe of discourse (or system of universally significant symbols) determined by the participation and communicative interaction of individuals'; (ibid pp 157, 158). Reflective thinking is genetically based on: play, which is only incipiently self-conscious; and games, which are consciously reflective systems of responses. Abstract thinking is the peak of this edifice:

> We have said that the internal conversation of the individual with himself in terms of words or significant gestures - the conversation which constitutes the process or activity of thinking - is carried on by the individual from the standpoint of the "generalized other". (ibid p.155).

This advanced type of thinking Mead says is determined by consensual considerations and not by the appreciation of evoked responses of particular individuals. But this final stage is reached by the organisation and generalisation of 'the attitudes of particular other individuals in terms of their organized social bearings and

implications'. (ibid p.158). Objective reflective attitudes will eventually be established in terms of viewpoints in general but may first arise from interactions with individuals whose influence is salient to the child. Thus Mead's approach is suggestive of a crucial role played by the particular individuals in relation to whom the child first establishes reflexive self-awareness - the mother is an obvious candidate here. It is therefore of considerable interest that four year olds in Light's study, who were most competent in role-taking tasks had mothers who expressed sensitive reflective attitudes to their children's point of view. This correlation cannot determine cause and effect but a tentative inference is suggested. Even if cognitive reflection in the role-taking tasks of Light's study is not exactly that required for seriation, reflective powers of some kind are common to both and appear to be basic characteristics of dialogue. Light's analysis leads one to consider which of the two social reflective influences, symmetrical 'reciprocity' or asymmetrical 'guidance' has most effect on progress in seriation. Insofar as role-taking skills appeared to depend more on characteristics of the mother-child relationship than the extent of peer contact, Light's results support the possibility that asymmetrical 'guidance' may be more important developmentally than the 'reciprocity' of equals.

Recently Genevan workers have begun to test the influence of social interactions on cognitive development. Although Piaget expressed views on the matter he did not put them to the test. Doise and Mugny (1975) have shown that children working in pairs on a spatial orientation task reminiscent of Piaget's 'model mountains' tests (Piaget and Inhelder 1956) perform better and make fewer errors than children working on their own. These findings occurred independently of age in groups averaging 5·9 and 6·8 years respectively. However since the task is perceptually a spatial one where objects have to be placed in a new orientation (their relationships to remain the same) differences in spatial perspective of two children are likely to facilitate the performance of a pair above that of a child working alone. Doise and Mugny point out that equivocal results of previous work concerned with analysis of the effects of social interaction on task competence probably reflect the nature of the tasks concerned. But they do not then comment on the fact that the model mountains situation is one which is particularly likely to be assisted by the synthesis of different spatial viewpoints when a pair or group of

children consider it together. It is important to realise that this is far less likely to be the case where logical relations must over-ride perceptual spatial notions as in the seriation of the present study. In the same article (Doise et.al 1975) Anne-Nelly Perret-Clermont considers the role of social interactions on the logical task of conservation of liquids (Piaget and Szeminska, 1952). As in study 1 of this project she follows Sinclair-de-Zwart's (1967) procedure in sequence of pretest, intervention tasks and post-tests. But unlike study 1 here she is not attempting to dispute Sinclair's conclusion that 'verbal learning' has no effect upon cognitive progress. Instead she explicitly accepts this. This leads her to ignore the role of speech in the social interactions which she then considers. Moreover without taking account of possible alternative forms of social interaction the situation she then establishes is clearly one containing 'guidance' and not a matter of reciprocal contentions between peers of equal cognitive status. The idea that results could be due to superior knowledge in one member of the dyad had only post hoc consideration by Doise and Mugny who then dismissed it. Without proper pretest control for the cognitive levels of the pairs of children concerned such arguments remain unconvincing. Perret-Clermont on the other hand set up a training situation based implicitly on the 'guidance' model which her colleagues had just dismissed. She arranged for two 'conserving' children to direct an 'intermediate' or 'non-conserving' child in pouring equal amounts of lemonade for them to share. Her results are of interest here especially if one can assume that discussion occurred between all three children. She found that 64.8% of 'non-conserving' or 'intermediate' children progressed as a result of exposure to instructions of the 'conserving' children. This progress was largely maintained at post-test II and was significantly better than that of the control subjects who had no intervention. This is similar to the progress contingent on the 'dialogue' condition B in study 2 here. Although Perret-Clermont gives little or no indication of the kind of discussion which occurred in her intervention it seems clear that it must have been of an asymmetrical nature very similar to condition B dialogue. This confers on her findings particular importance for the present argument. Notably the best progress made by her 'intermediate' and 'non-conserving' subjects was associated with relevant and consistent reasoning on the part of the 'conserving' pair who directed the

non-conserver's actions. 73% of subjects who were exposed to such consistent arguments made progress. Only a momentary lapse to less appropriate reasoning reduced the associated progress in non-conservers to 50%. Perret-Clermont says 'These observations indicate the importance for the NC child of not simply being in the presence of equals and interacting with them but of being confronted by partners who defend a different mode of reasoning in a stable manner' (ibid. p.382). Apparently the outcome of her study supports 'guidance' as the effective factor in producing advance in understanding conservation but the question of 'reciprocity', or as she puts it 'simply being in the presence of partners' is indistinguishable in her study. She does in fact outline three possible characteristics of social interaction which may be responsible for the advance: 1) other children who make the subject aware of other points of view; 2) 'conflict of communication' (Smedslund 1966) arising from confrontation between subjects of different cognitive levels which make the subject aware of contradictions in his mode of reasoning; 3) majority pressure, there being two conservers to one non-conserver. The first two possibilities correspond in some respects to the two features of dialogue distinguished here, namely, 'reciprocity' and 'guidance'. The third is of little interest in the present context. Had external pressure been a significant force shaping cognitive organisation the didactic condition C of study 2 would have been at least as effective as dialogue with the observer. Doise and Mugny did not define the cognitive level of their subjects. Thus their consideration of an informing influence provided by more advanced subjects was speculative. Perret-Clermont set conservers to 'guide' non-conservers but she had no contrasting situation where peers of equal cognitive status could contest the conservation problem from different points of view. Thus 'guidance' and 'reciprocity' were confounded in her results. The aim of the next study (3) here is to draw just this contrast. In order to do so achievement in post-test seriation of group B, the 'dialogue' condition may be compared with that of pairs of 'intermediate' seriators who resolve the same interpolation task together. Condition B is a 'guiding' dialogue, the interaction of the pairs should contain 'reciprocal' symmetrical discussion. The outcome in post-test seriation of this comparison should show whether role-taking is in itself a sufficient developmental influence to produce progress in seriation or whether there must be the additional spur of sustained

adaptable guidance from an experienced mentor.

STUDY 3: THE PAIRS CONDITION

METHOD

Design

The design of study 3 was exactly the same as that of study 2 in selection criteria, the procedure of seriation and interpolation tasks and their sequence and timing. But 10 'intermediate' seriators who did the same interpolation problem as in study 2 resolved it by mutual discussion in pairs. Their individual achievement in post-test seriation was then compared with that of group B, the dialogue condition of study 2. Study 3 was thus in effect an extension of study 2 since one more intervention condition was added whilst the same design and procedures were retained. This allowed for comparison of the results of all groups (A,B,C and D) with E, the pairs group, the comparison of E and B being the main focus here.

Subjects

Ten 'intermediate' seriators were selected in the same manner as before on the same operative and descriptive criteria. They came from the first of the three schools mentioned on page 49. They were paired only for the purposes of solving the interpolation task there being 2 pairs of girls and 3 pairs of boys. Their mean chronological age was 5•6 years.

Materials

For seriation tasks, the interpolation problem and for video recording, all materials were the same as in study 2 except that one extra set of 7 blue and 2 yellow squares of the same dimensions as the first were added for purposes of comparison in the interpolation task. For this task the shapes were set out on a long board (a) 3 feet by 18 inches, and the extra comparison set of shapes were arranged on another smaller board (b) 2 feet by 18 inches.

Procedure

All the procedures except those of the 'pairs' sessions of which there were three on consecutive days, were exactly the same as in study 2.

Pairs procedure

One member of each pair of children stood on either side of a small table about four feet away from the camera. The long board (a) was placed on the table between them slightly tipped towards the camera. The 3 foot length of the board lay horizontally to the children, the camera had a vertical view. As before in the interpolation tasks of study 2 a model size-order arrangement of circular discs was used to demonstrate the nature of the task. The circles were placed on board (a) lying horizontally to the children at the end nearest the camera. This allowed the children space to set out the squares for the insertion task itself between them on the board. The big and small end squares were first placed horizontally between them on the board before they were asked to take items from the bag and to decide whether or not they should be placed between the end squares. The general procedure was as far as possible exactly the same as for all those of the intervention conditions in study 2. However it was important to avoid explanations by the observer which would give the children the same 'guidance' as in condition B. Thus instead of using or eliciting the descriptions of specific size comparisons these were demonstrated to the child by placing shapes together as in condition A. The purpose of the task was represented as 'finding those that will go in between the big and little square so that the size order is right'. The children were asked to see if they could do this game together by helping each other to get it right. Each child must take turns in placing items taken from the 'secret bag' while his peer tells him what to do and judges whether it is correct. They were specifically encouraged to talk about their decisions together; to say each time whether they agreed or not on the placement made and they were told that for each item they must come to an agreement before the next turn was allowed. When all the items had been placed the observer would tell them if they had succeeded and show them another set of squares which were exactly the same as these except in colour and which were arranged correctly. These were already set out but kept out of sight until required. They consisted in the extra set of squares placed on board (b). After explaining the rules of the game the observer let the children play and confined her part to ensuring that the rules were kept. In particular she encouraged the children to discuss their placements. Because size differences were small children sometimes agreed on a wrong placement which could give rise to a

fruitless trial and error sequence of moves. This would be halted by the observer who then showed the correct model. By the second session these tendencies had been ruled out. Finally the observer demonstrated the reversal procedure in the same way as for condition A in study 2 (p.55).

RESULTS

Data were treated and analysed for the seriation tasks in the same way as for study 2 and comparisons for the combined results of achievement at both post-testsin the 'pairs' condition were compared with those of study 2. As previously a comparison using the Wilcoxon matched-pairs signed-ranks test showed there was no difference between post-tests of this condition (N=2 n.s.). Inspection of the scores suggests that there are no differences between results of this condition and those of conditions A, C and D of study 2. (cf. Table I, below of this study and Table II, p.61, of study 2). A comparison of these conditions (A,C,D and E) using the Kruskal-Wallis one-way analysis of variance confirmed this (H = 0·66 df 3 n.s.). But comparison of the 'pairs' condition (E) with the 'dialogue' condition (b) using the Mann-Whitney U test <u>did</u> show a significant difference in favour of the dialogue condition (U=8·5 n_1=10 n_2=10 $p<.01$, two-tailed).

Table I Post-test seriation achievement for group E, 'pairs'

Group E, the 'pairs' condition

	Post-test I					Post-test II				
	Tasks			Score		Tasks			Score	Total
Subjects	1	2	3		Subjects	1	2	3		
1	I	I	I	1		I	I	I	1	2
2	I	I	I	1		I	III	I	1	2
3	I	I	I	1		I	I	I	1	2
4	I	II	I	1		I	I	I	1	2
5	I	I	I	1		I	I	I	1	2
6	I	I	I	1		I	II	II	2	3
7	I	I	I	1		I	I	I	1	2
8	I	I	I	1		I	III	II	4	5
9	I	II	I	1		I	I	I	1	2
10	I	I	I	1		I	I	I	1	2

Summary of main results

The dialogue of condition B between observer and child remains the one effective condition to promote progress in seriation. Interactions

containing dialogue between peers of equal cognitive status was no more effective than all the other conditions of study 2, namely, the 'didactic', the 'action' and the 'control' conditions. Thus the effective action of reciprocity in role-taking which is of a symmetrical type seems no more than a necessary part of the process of change. Instead reciprocity of a more complex asymmetrical type is required.

ANALYSIS OF THE 'PAIRS' DIALOGUE

The difference in outcome between the 'dialogue' condition B of study 2 and that of the 'pairs' of study 3 here suggested the need to analyse the exact characteristics of the 'pairs' interactions. The 'guidance' quality of condition B dialogue has been fully described (pp.65,66). In study 3 here it was assumed that pairs of subjects of equal cognitive status would take different points of view in resolving the insertion problem and would express this to some extent in speech if they were suitably encouraged. This would be the symmetrical interaction which may force a child to realise other points of view. This has here been designated 'reciprocity' as opposed to 'guidance' which is clearly asymmetrical. Analysis of the 'pairs' interaction is designed to discover: 1) whether there was sufficient contention between the pairs to regard the condition as reciprocal; 2) to what extent this was expressed in speech; 3) and what level of discussion arose in terms of appropriate reasoning. Analysis of these points will provide some detail about the nature of the contrast being drawn between 'reciprocity' and 'guidance' in symmetrical or asymmetrical dialogue.

The proposed analysis was made on the basis of each decision taken between a pair of children. For each child's turn a decision had to be taken for the placement of each consecutive item and these interactions consisted in discrete utterances which were not necessarily grammatically complete. These were the units of analysis. Some of these interactions were only demonstrative gestures. The first analysis consisted in counting the number of agreements or disagreements at each decision for each pair of children. Agreements were usually reached promptly to be followed by a correct placement. Disagreements took various forms and resulted in new placements being

made. Types of disagreement which were all classified as such were: flat contradictions; tentative objections; seemingly independent monologues reflecting on the problem. All these were finally resolved into a mutual decision on where to place the item concerned. It will be clear that although there were only 7 items for placement and if agreement was directly reached on each of these there would only be 7 decisions made between the pair. Disagreements resulted in fresh placements and extra decisions. The number of agreements and disagreements was approximately equal (55%/44%).

Reasoning was categorized at four levels:

1) definitive and appropriate reasons e.g. the 'three element description' is given.

2) size differences are described but only in one direction e.g. 'It's slightly bigger' or 'It's slightly smaller'.

3) the explanation is unspecific e.g. 'It goes there cos -' the child pointing to a disparity in size between elements, or 'Let's measure', or 'Middle - now which one must go?'.

4) the child gives no reason but instead points to or traces with his finger the disparities between the tops of the shapes by way of demonstration to his peer.

Table II (p.78) depicts the raw scores for agreements, disagreements and reasons and Table III (p.78) expresses these as percentages of the total number of decisions for the former and the percentage of different types of reasons in terms of their total for the latter. These data are represented for each of the three sessions worked by each pair. It is also noted where the children arrived at an incorrect result. Inspection of the tables shows that this occurred in only three sessions. It is also clear from these data that no type 1 reasons were given in the pairs discussion and very few of type 2 (2 of the pairs each produced 7 such reasons respectively). Unspecific reasons and demonstration occurred in equal proportions although as there was plenty of disagreement (44% disagreements to 55% agreements), there was ample opportunity and incentive for advancing specific reasons. The number of decisions varied because disagreements led to extra placements.

Table II

The number of decisions (agreements/disagreements) and types of reasons (1,2,3,4) occurring between pairs of subjects:
(+ = correct, - = incorrect).

Subjects paired	sessions		Decisions Agreements	Decisions Disagreements	Reasons Types 1	2	3	4
1	I	-	29	16	0	0	13	34
2	II	+	11	9	0	0	15	10
	III	+	21	10	0	0	15	18
3	I	+	5	5	0	0	8	4
4	II	+	11	23	0	0	12	18
	III	+	14	3	0	7	4	8
5	I	-	11	7	0	2	2	10
6	II	+	6	2	0	0	1	6
	III	+	16	6	0	5	3	12
7	I	+	6	6	0	0	4	8
8	II	+	7	15	0	0	10	10
	III	+	4	8	0	0	8	6
9	I	+	3	4	0	0	0	7
10	II	+	12	7	0	0	1	16
	III	+	9	11	0	0	11	10
Total			165	132	0	14	107	177
Percentage of Total			55	44	0	4.7	36	59

Table III

Agreements/disagreements expressed as a percentage of all decisions and percentage of types of reasons for each pair at each session:

Subjects paired	sessions	Decisions Agreements	Decisions Disagreements	Reasons Types 1	2	3	4
1	I	64	35	0	0	27	72
2	II	55	45	0	0	60	40
	III	67	32	0	0	45	54
3	I	50	50	0	0	66	33
4	II	32	67	0	0	40	60
	III	82	17	0	36	21	42
5	I	61	38	0	14	14	71
6	II	75	25	0	0	14	85
	III	72	27	0	25	15	60
7	I	50	50	0	0	33	66
8	II	31	68	0	0	50	50
	III	33	66	0	0	57	42
9	I	42	57	0	0	0	100
10	II	63	36	0	0	5	94
	III	45	55	0	0	52	47

DISCUSSION

In answer to the main issue raised in this chapter the results provide clear evidence that it is a 'guiding' type of dialogue which activates progress in seriation here and not just the clash of different points of view which occurs between cognitively equal peers. Analysis of the interactions which took place between the pairs in resolving the insertion problem showed that they disagreed as much as they agreed. Even if some of their dissension was not well articulated there was plenty of opportunity for each child to be aware of an opposite point of view and because of the rules of the game, to realise that these could be resolved. The 'pairs' interactions were reciprocal in nature, but they were not characterised by particular adaptability on the part of either child. Of course decisions always culminated in agreements before each new item could be placed but none of these was the outcome of reasoned discussion concerned with the essential relationships of the task. Thus it seems unlikely that either child of the pair was ever fully understanding why their mutual placement was considered to be correct. No type 1 reasons were advanced (the three element description). Even type 2 reasons were rare (one-way size differences described). They were both adapting to each other in judging what they saw as correct in the size relations of the task without articulating these in detail. Of course according to Piaget's (1926/1959) ideas about children's quarrelling one might envisage that one child would stress the relations in one direction e.g. 'It goes in there because it's smaller than that' and another child would say 'No it does so because it's bigger than that one'. Instead, what happens is far less articulate. Comparative descriptions are evoked too seldom to bring about contention at this level. Piaget's (1926/1959) earlier views on peer interaction are clearly insufficient although much of his subsequent theorising seems to require a revision even in his own terms. The adaptable guidance which promotes cognitive progress seems to be geared to the accommodating needs of the child with direct reference to the task he is resolving. Thus Piaget's self-regulating processes are satisfied. But the whole story is not accounted for unless one also admits the part played by 'particular others' whose inclusive understanding of the task and child provides the child with the exactly appropriate opportunities he needs for understanding the task in objective terms.

The asymmetrical 'guidance' of the effective dialogue here is thus complex and specific. Reciprocity is a necessary feature but without the particular asymmetrical adaptability brought about by the superior knowledge and wider viewpoint of the leading member of the dyad this is apparently no more effective than independent effects of speech and action in the previous study. Besides the sensitive adaptability which the observer contributes, she has this quality by virtue of two important aspects of her task: knowledge of the essential relations of the problem mutually being resolved; and appreciation of the child's limited view of it. The first relates to the kinds of referential descriptions required, the second to their specific use in the particular circumstances.

It is hoped to identify the contributions of these two factors in the next two studies of this project.

Chapter 5

EXTENDING THE COMMUNICATION PARADIGM

It is the purpose of study 4 to analyse further the complexities of asymmetrical dialogue. In this dialogue speech and action are combined in the negotiations which are guided by the observer and formulated by the child. The whole operation is focussed on the task of resolving a problem together but from different angles. Because it is a problem and because two different persons are adjusting to each other's approach in solving it the nature of the process is open and constructive. From the child's angle the problem itself is novel; he himself must organise sets of relations and at the same time express them appropriately in speech which will suit what he believes to fit the situation as the observer sees it and as he sees the relations of the problem themselves. The particular asymmetry of the dialogue lies in the child's inexperience counterbalanced by the observer's highly reflexive capability which she derives from her command of the problem and the child's view of it. She can dove-tail her responses and her questions exactly to the child's immediate needs but she also must innovate in doing so because she does not know what his responses will be in advance. In this open constructive process one may say that there are at least two interdependent adaptive systems at work; the communicative and the referential.

Both are evident in the child's behaviour. This follows increasingly coherent functional patterns and the observer's part meshes with these. In all the studies of this project it is clear that children do become more effective and systematic in operating ordinal relations and in describing these appropriately. At each step the child combines perceptual judgements, actions and descriptions in terms of the task as he sees it then. But the way he organises his responses changes constantly according to the immediate ends he envisages and the effectiveness of his actions in terms of these ends. This process of change appears to be moving towards the relative stability of 'operational' seriation competence. Present results show this to be happening significantly faster where asymmetrical dialogue enters into the process. The process which is taking place is: synchretic, not additive; open, not closed; transformational, not static; and it is reflexive. It seems to be a process where

functionally determined wholes become organised cooperatively. This account of cognitive construction and its formulation fits Piaget's structural analysis of the epigenesis of knowledge and of thought. According to Piaget, thought structures are pictured as synchretic wholes which are constantly transforming according to the functions they serve. The primary and universal processes of assimilation and accommodation are functionally adaptive. These functions determine a constant progression towards states of relative but always changing equilibrium:

> So assimilation, the process or activity common to all forms of life, is the source of that continual relating, setting up of correspondences, establishing of functional connections, and so on, which characterises the early stages of intelligence. And it is assimilation, again, which finally gives rise to those general schemata we call structures. But assimilation is not a structure. Assimilation is the functional aspect of the structure formation, intervening in each case of constructive activity, but sooner or later leading to mutual assimilation of structures to one another, and so establishing ever more intimate inter-structural connections. (Piaget 1971b,p.72).

It is clear that Piaget's assumption should apply equally in all areas of human functioning. The same interdependent systems of transactions should occur in individual-object relations and between individuals themselves. Piaget is well aware of this:

> Intellectual interaction between individuals is thus comparable to a vast game of chess, which is carried on unremittingly and in such a way that each action carried out with respect to a particular item involves a series of equivalent or complementary actions on the part of the opponent; laws of grouping are nothing more or less than the various rules ensuring reciprocity of the players and the consistency of their play.
> More precisely, every grouping within individuals is a system of operations, and co-operation constitutes the system of operations executed in common, i.e. co-operations, in the true sense of the word. (Piaget 1950 pp.165/6).

But Piaget's preoccupation with epistemology leads him to focus almost exclusively on individual-object transactions and to overlook the importance of reciprocity between individuals which he himself mentions. This is evident not in the way he writes about his theory (Piaget 1970a) but in the fact that his clinical observations do not include a consideration of social transactions. An analysis of the communicative systems which relate the individual to his social context would provide a useful counter-balance to Piaget's 'referential-system' bias. To concentrate too

heavily on the individual as self-regulator carries the risk of underestimating the influence of communicative systems of relations which may be inextricably interwoven with those referential systems which the individual is currently negotiating. It is quite possible that what Piaget calls 'co-operations in the true sense of the word' (cf. Piaget 1950 p.166) that is, consensual adjustments in objective terms, are necessary to the growth of logical understanding in the early years (children of 5 - 6). Of course this would assume that the consensual adjustments allowed scope for the individual to be negotiator for himself vis-a-vis 'objects' and 'others'. In other words the child must have freedom to adapt, but this adaptation is is relative to that of 'others' as well as 'objects' and 'events' in his experience. The asymmetrical dialogue seems to provide just this facility.

The importance of the communicative system for cognitive development is central to Mead's (1934) theory. Light (1974) points out that both for Piaget and Mead 'role-taking emerges from both theoretical frameworks as a prototypical social-cognitive skill' (ibid p.204). It is thus 'a bridge' between thinking and social interaction. Perhaps then it is a necessary characteristic of the formulations which take place in the course of cognitive acquisition - a point to be discussed presently (p.100). But role-taking is part of communicative systems of interaction. These have been analysed in terms of General Systems Theory by Watzlawick, Beavin and Jackson (1968) drawing on the work of Bertalanffy and of Bateson. Their analysis of social interaction patterns is similar to Piaget's description of cognitive structuring. Most pertinent here is their account of open-communicative systems although the reiterative complementary social interaction patterns they describe fit the kind of exchanges occurring between pairs of children in the previous study here (p.77). For them positive and negative feedback stand for Piaget's assimilation and accommodation process. Communicative systems like Piaget's thought structures, are changing according to functional laws which lead either towards stability, or to change, according to present needs within a particular context of interactions.

> In a circular and self-modifying system, "results" (in the sense of alteration in state after a period of time) are not determined so much by initial conditions as by the nature of the process, or system parameters. Simply stated, this

> principle of equifinality means that the same results may spring from different origins, because it is the nature of organisation which is determinate. (Watzlawick et al. 1968 p.127).

And as the above quotation implies, the complex interdependence of aspects of a system in action, which may vary in essence but remain stable in function, suggests that useful analysis cannot follow simple cause-effect sequences; the nature of the system itself is its own best explanation. Moreover, because change is the essence of such a system any information which contributes to this must be seen as part of the ongoing process and not as static units of knowledge.

The 'learning studies' undertaken so far in this project are in effect small longitudinal sequences where different types of intervention for matched groups of subjects provide the framework for considering alternative hypotheses. But this approach should not allow simple cause-effect assumptions to be made based on some kind of additive paradigm of cognitive processes. Instead the interventions which are most effective in activating cognitive restructuring must be seen as functionally coherent with the ongoing system-process; they do not independently determine it. This applies equally to communicative or to referential aspects of the process. In either case, conditions of intervention which are not consistent with the natural process being studied should not produce cognitive reconstruction. Such features or conditions may be either irrelevant or perhaps even disruptive. At any rate they play no part in the particular structural organisation. On the other hand activating influences are not thought of as sufficient, or even necessary causes since given time cognitive structures may emerge by different routes, e.g. deaf or blind children are unlikely to reach operational understanding in the same way as children who have no sensory deficits. In the present investigations indirect inferences about the role of speech in cognitive development are permissible in the sense discussed above. But it may be argued that direct observations of how cognitive acquisition occurs during intervention sessions would reveal more about the processes under study. Perhaps in this way one may discover unforeseen characteristics of the formulation process occurring in the dialogue. But direct observation can do no more than observe a child's behaviour in particular circumstances; his thinking is always inferred from his behaviour in response to the circumstances which the observer has chosen for him. This means that observation is inevitably preselective. It is of course Piaget who has used direct

observation as the basis for all his work. His strength lies in the ingenious situations he devises to uncover characteristic ways of responding and from which modes of thinking may be inferred. But it is important to note that Piaget is not concerned with 'proof' based on a causal paradigm. Instead he seeks for coherence within the system of systems which he envisages; the operational structures of intelligence within all other biological systems (Piaget 1971a). Following in Piaget's tradition Inhelder, Sinclair-de-Zwart and Bovet (1974) instituted a series of directed learning studies. Sinclair-de-Zwart's (1967) work is cited amongst them. Apart from the fact that study 1 of this project was based on that of Sinclair-de-Zwart the other studies are of some interest here because they are an attempt to observe learning processes directly, albeit in controlled situations. The particular aim of these studies was to highlight the ways children deal with contrasts and paradoxes in problems concerned with number, measurement and length, and class inclusion. Children were pre- and post-tested in these forms of understanding in order to gauge their progress but the learning situations themselves were the main concern. These situations confronted children with perceptual contrasts, for instance, the observer asked the child to match a particular match-stick arrangement for <u>length</u>. This the child must do using his own set which were <u>shorter</u> than those in the model. The discrepancy between number and length had to be resolved if the child was to produce a copy of the same length as the model. In all cases children were allowed to work with objects to produce a solution and always they discussed their work with the observer who made a particular point of drawing the child's attention to inconsistencies in his arguments. Inhelder et al. noted the tendency of preoperational children to adhere with confidence to unsuitable solutions. Other children moved swiftly to operational answers. Among these the process of acquisition was indiscernible. Intermediate children were particularly likely to fluctuate in judgements and produce quasi-solutions such as breaking some of their own match-sticks in half in order to produce the same number as those in the model whilst still judging length by the end points of the model and not its actual dimensions. Of particular interest here is the fact that the amount and type of progress occurring in the Genevan study was very similar to that of the dialogue condition B here. It was usually a matter of small advances resulting from a gradual synthesis of relational judgements

but the Genevan workers give no consideration to the fact that children discussed their problems extensively with the observer. It is sufficient for them that Sinclair-de-Zwart dismisses the influence of 'verbal learning' on the basis of her findings. It is a pity that this factor is thus artificially separated from the communications occurring in the dialogue. In the present project it is just this influence which is of interest. Following the Genevan line it is intended in study 4 to observe the way in which children formulate their solutions of the intervention problem and thus to try to analyse in more detail the processes occurring in the dialogue. Particular features which may be observed in this process will then be related to post-test seriation outcomes in order to evaluate their importance in cognitive development. Also the quality of progress will be compared with that of the Genevan studies.

As discussed on page 48 Piaget's theory only properly accounts for the referential aspects of cognitive development. Present results indicate clearly that discussion with the observer has a significant part to play in the seriation progress which follows. There seem to be at least two interdependent aspects of the formulation process in the dialogue, the communicative and the referential. Study 4 aims to 'amplify' or extend the communicative function. Central to this communicative aspect of formulation is the necessity for the child to express his ideas objectively. In order to be able to do this, according to Mead, he will be reflecting on his own speech as observable by 'another' (here the observer). In effect the child begins to realise the way someone else to whom he is speaking may understand what he says. Thus he begins to take the point of view of the other discussant in the dialogue; their common negotiations gradually arrive at precisely dove-tailed meanings (Mead's 'significant symbols'.) The understanding by the child, of what he is trying thus to express may well be at least partly a function of the reciprocal negotiation inherent in expressing his ideas to 'another'. John Shotter says:

> A sentence is something one uses to express one's meaning, and it is not an expression of meaning itself; its meaning is a logical construction to be completed both by oneself and one's listener out of the influences exerted by one's utterance. (Shotter 1974 p.238).

The proposed study:

Study 4 is an attempt to observe the interdependent relationship of the communicative and the referential functions which seem inherent in the asymmetrical dialogue. It is concerned to see these as united functions by which the child acquires an understanding of the insertion problem and seeks to discover ways of formulating his new conceptions. In order to show these processes the more clearly it is hoped to extend the characteristics of the observer-subject dialogue in some way which will oblige the child to be entirely explicit. In this dialogue there seems to be no way in which the communicative and referential processes can be separated for inspection without destroying exactly what one hopes to analyse since their interdependence is the main feature of the process under inspection. This must be accepted. The idea of amplifying one aspect (the communicative feature) may be achieved by adding some requirement beyond that which the observer can elicit. In talking to her the child must realise that she knows the answers. Therefore much of what he could say about the matter can thus be presupposed. Perhaps if the child had to explain himself in detail one might be able to detect how the dialogue he had with the observer was affecting his progress in understanding. Clearly this dialogue has had a constructive effect. A realistic context in which he would have to provide full explanations would be one in which the child must teach the insertion task to a less experienced pupil but this presupposes that he already knows the solution to a problem he has not yet resolved. Study 3 has shown that pairs of children as yet only acquiring an understanding of serial relations do not between them elicit full descriptions and explanations from each other. These problems seem insurmountable in an entirely natural setting for the child cannot teach what he does not know and if what he is teaching is known to him sufficiently well to teach it independently of the observer then he has already reached the level of understanding whose acquisition-process one is trying to follow. However a possible expedient may be to engage the child in 'teaching' his solutions, just discovered in the observer-subject dialogue, to a glove puppet depicted as rather ignorant and stupid. In this way the observer's guidance will continue to be available in the puppet's answers and questions and if the child is prepared to play this role-taking 'game' and thus imagine the puppet as a separate character from the observer who operates it, it may be possible to study the child's formulations in a

in a situation in which the child sees the necessity for full exposition and feels free to do so with less constraint than when talking to the observer. Children from about 18 months onwards begin to play imaginatively with objects which may have little resemblance to the notions they represent to the child. Donaldson and Lloyd (1974) found children of 3 years were more forthcoming in their communications than usual in a game which involved talking to a Panda. Admittedly this panda had its own voice but they attribute children's responsiveness to the fact that the panda was represented to the child 'as a creature who could not speak very well and who might need help' (Donaldson 1977 pp. 286,287). To recapitulate: the method adopted for study 4 was to select children exactly as in studies 2 and 3, to engage each child individually in the same insertion problem as was used before for the dialogue condition B with the observer and then to ask each child to teach his solutions to a glove puppet who can discuss the problem with him and who is characterised as 'not very clever'. (The observer supplied the puppet's voice). Provided that children enter into this imaginative role-play and separate the person of the observer from the rather comical and stupid puppet, treating it as such, certain aspects of formulation may be detected:

The main concern is to detect any indications of reflexive awareness as the child formulates the task for the sake of the puppet, and at the same time any indices of detaching thought from action. The relationship of competence in these features to post-test progress in seriation would suggest how role-taking by influencing reflexive thinking enters into cognitive reorganisation. Such indications of reflexive awareness of the task and its explanation for 'another' may be: i) the degree to which the child does formulate reasons appropriately, i.e. the relations which determine insertion of an element in an ordinal size series; ii) the extent to which the child can explain to the puppet how <u>it</u> may understand and verify these relations; iii) how far the child is able to 'tell' the puppet independently of demonstration. The last two features would tend to be specific to the puppet-dialogue rather than the observer-dialogue because it is just to these areas of explanation that the child must extend himself when he considers his own exposition of 'another's' actions. Perhaps point ii) lies nearest to the basic logic of the seriation task. It is true that the combined use of 'bigger and smaller'

for justifying the insertion of an element between items of different size provides the reason for its placement, but to realise that these combined relations are common knowledge by virtue of common judgements indicates an understanding of verification i.e. the area of knowledge where the veridical and the consensual meet and the most direct link of speech to action. It is not of course assumed that anything like such an abstract objective notion is presently available to these children, but it is possible that formulation to 'another' begins the process of logical verification; the role-taking involved in communication with a 'particular other' may lead to the broader notion of the 'generalised other' and the proper use of 'significant symbols', to use Mead's account of the story. If this is so then these characteristics of formulation will relate to post-test seriation progress in a positive way.

If the child does play the 'puppet-game' then post-test seriation should have the same outcome as the observer-subject dialogue of condition B study 2. This is because the quality of discussion in both is the same. Here in any case as the child has not yet solved the problem he has to do so with the observer before explaining it to the puppet. There is little chance that the extra discussion involved would give the puppet session an advantage over that with the observer since quantity has had no effect in any of the conditions so far observed. The alternative that discussion with the puppet would be disruptive would easily be observed by the child's inability to cooperate. In this case the procedure would have proved useless.

As an attempt to observe the ongoing process of formulation the quality of progress during these sessions and in post-testing may be compared with findings of the Inhelder et al. (1974) study.

METHOD

Design

A group of 10 children (5 boys and 5 girls of mean chronological age 6.1 years, range 12 months) were selected in the same manner and for the same operative and descriptive criteria as in studies 2 and 3. They were all drawn from the second school used in this project. Following the pretest those who were thus selected were given three

intervention sessions on subsequent days and two post-tests in seriation in the same sequence and with the same time intervals as before. The intervention sessions replicated the previous observer-subject dialogue condition B of study 2. However, in addition each child was required to teach the interpolation task to the glove puppet. All sessions including the intervention tasks were video-recorded.

Materials

For seriation tasks the materials were the same as before in studies 2 and 3.

For the interpolation tasks: the same circular discs and squares were used as in studies 2 and 3 with the addition of a same sized set of squares for the use of the puppet. The puppet had yellow squares to insert between blue 'end squares' which was the reverse colour arrangement to that of the child who had blue insertion squares with yellow 'end squares', otherwise there was no difference.

There were two plywood boards covered with brushed nylon, one for the use of the child, the other for the puppet.

Video recording equipment was the same as before.

Arrangement

The general arrangement of the camera in relation to the child working at his tasks was the same as in study 2. In order to include the puppet however the child's table was slanted obliquely to the camera with the puppet's table facing it. The child's board, as before was tipped slightly in the direction of the camera as also was that used by the puppet. These very slight inclinations were adjusted to suit the child's view and that of the camera. All the furniture as in all previous cases, was designed in size for children of this age. The observer used one of the small chairs placed opposite the child at the puppet's table in a position which enabled her to reach the starter button on the camera and to operate the puppet with a minimum of movement between each.

Procedure

Pre- and post-test seriation procedures were exactly the same as in studies 2 and 3.

The Intervention procedure was the same as that used in condition B of study 2 where a model arrangement of circular discs was used as an example for explaining the task (cf. p.54). However at the

beginning of the intervention session of study 4 the child was introduced to the glove puppet. The child was told that after he had 'played the game of finding where to put the shapes' with the observer he would then have to teach it to the puppet who was not very clever and so would need very careful explanation. Most children immediately invented a name for the puppet when they were asked to suggest one and these names indicated that they had decided its sex from the start. The puppet was made to sit on the end of the table to watch the task being done by the child with the observer. When all the shapes had been placed and the reversal procedure completed the observer asked the child to teach the game to the puppet. The puppet had its own 'secret bag' containing its own set of shapes which it drew out at random. The child was asked to tell the puppet what to do and why. If he tried to demonstrate with the puppet's shapes he was discouraged. The child's shapes remained where they had been placed on his own board and could be referred to if he wished. If the child did not spontaneously instruct the puppet at each step of the procedure the puppet asked him what to do. It also asked why items were placed between 'end squares' or discarded and how it could judge correct placements for itself. Then, as before, end elements were reversed by the observer, and the child was asked to explain to the puppet whether items lying between them were still correct and why. The puppet frequently made wrong judgements or moves which were firmly corrected by the child who was thus led to justify his own reasoning very thoroughly.

Transcription of video recordings:

For the pre and post-tests this transcription was made in the same way as for these tasks in studies 2 and 3.

The puppet sessions were transcribed in the same way with some extension of the coding. As before action and speech were set out in parallel columns the child's performance in each being written in upper case, those of the observer and puppet in lower case. For ease of coding the puppet's actions, speech and objects were indicated in red. The squares were coded for child and puppet from the smallest to the largest items as S1,S2,S3 -- ES -- M1,M2,M3 -- EL -- B1,B2,B3. ES and EL designated the small and large end-squares respectively. S indicated any square that was too small to be inserted between them labelled in order of size. M applied similarly to squares which would correctly go between the end-squares. B,1,2

and 3 were the squares which were too large to do so, labelled as before from the smallest to the largest. Thus B3 was the largest square in the set and S1 was the smallest. The child's items were indicated in black typescript those of the puppet in red. The following observations were noted: whether the subject (S) addressed the observer (O) or the puppet (P), i.e. who did he look at when speaking; the child's actions related to placing items e.g. making comparisons which were either careful such as placing one item upon or against another, or vague, such as just looking from a distance; where the child directed his attention when explaining something e.g. to his own, or to the puppet's items; whether he pointed at all or whether he relied on explanation alone. If he did not point how he sat and whether he made other gestures e.g. did he sit back or lean forwards, nod his head in lieu of pointing etc.; whether his placements were right or wrong.

Example protocols

Excerpts from the first and third puppet-sessions of three children are here paraphrased in order to illustrate some of the types of interaction occurring. The subjects may be identified in tables of results which follow by the letters which designate them. (Table I and II p.98). Abbreviations are those adopted for transcriptions which are outlined above.

Subject i) Session I:

> The puppet extracts M3 and says 'Now what do I do please?' YOU PUT IT ON HERE, S indicates placing it over her own EL. P, 'Yes and?' THEN PICK IT UP AND PUT IT THERE, S indicates on her own set the position next to EL. P, 'Why does it go there? BECAUSE IT'S NEARLY THE SAME SIZE AS THAT ONE, indicating EL in her own set and sitting back... Asked why M1 goes between ES and EL S replies BECAUSE IT'S SMALLER THAN THAT ONE AND BIGGER THAN THAT ONE. She indicates the items on her own set. P, 'And how can I tell that it is?' BY PUTTING IT ON AND SEEING

Subject i) Session III:

> P is placing M1 and discards it. NO IT GOES IN BETWEEN. P, 'Oh why?' BECAUSE IT'S TOO SMALL FROM THE BIG ONE AND TOO BIG FROM THE LITTLE ONE ... TRY IT ON ONE. P, 'Like that?' YES, TRY IT ON ANOTHER ONE. S instructs P without pointing here and smiles in a relaxed manner.

Comments on subject i): She is a child who makes good post-test progress in seriation. Even in the first puppet-session she is prepared to explain its actions to the puppet by reference to her own

set of items although its responses relate to its set. She can give it appropriate reasons for correct insertion and also a strategy of comparison by which this can be judged to be so.

Subject f)Session I:

> S places his finger on his own middle shape (M3) after inspecting the one the puppet is holding. He says, PUT IT THERE. The puppet places its M3 beside its EL (the position indicated by the child). P, 'How do I know that's the right place please?' S, BECAUSE IT'S BIGGER THAN THAT ONE AND SMALLER THAN THAT ONE, leaning over and touching the puppet's large and small end-squares. P, 'How do I know it's bigger than that one and smaller than that one?' The child looks at the puppet, and fidgets, says BECAUSE, pauses. P, 'Is there any way I can tell for myself? How would I know it myself?' The child looks at the puppet, looks at the observer, nods and says, BECAUSE IT GOES IN BETWEEN.

Subject f)Session III:

> The puppet has M3 to place, S leans forward to look at the puppet's items, I THINK IT GOES IN THE MIDDLE ... P, 'How can I tell?' COS IT'S BIGGER THAN THAT ONE AND SMALLER THAN THAT ONE. S leans across and points to the relevant items in P's set. ... 'How did I know it was?' COS IF YOU MEASURE YOU CAN'T SEE THAT, S seems to point to the puppet's ES. P, 'And how can I tell it's smaller than the big one?' COS IF YOU MEASURE YOU CAN STILL SEE SOMETHING, looks towards P's EL.

Comments on subject f: This boy does make some progress during the puppet-session. Initially, although he can give appropriate reasons for insertion he is at a loss to explain how the puppet may judge these for itself but in session III he explains measurement to the puppet. He tends to point to the puppet's items. He makes little post-test seriation progress.

Subject a) Session I:

> P. takes M3, 'What do I do with this one to find out?'. The child hesitates for a period her head in her hands, glancing from the shape in P's hand to items on the table. 'Tell me', HERE, S stands up leans over to P's items and points between EL and M1. 'Is that all right?' YES 'Because?'. IT'S SMALLER THAN THAT ONE, S points to the puppet's large end-square (EL), 'And from the little blue one?' SMALLER

Subject a) Session III

> P has M1, 'What do I do, put it in between there?'. YES, S looks at P's shapes, leans across and points between EL and M3, sits down and glances over her own items then at P's placement. 'Is that all right?'. YES. 'Oh from that one it's?' SMALLER 'And from that one it's?' BIGGER.....'How do I know?' COS YOU MEASURED IT.

Comment on subject a): she responds only after prompting; she does not actively teach the puppet, is inclined when asked by the puppet to demonstrate on the puppet's own items even though this has been discouraged. She is able to give appropriate reasons for placement but does not easily say how the puppet can know these for itself. Her progress in seriation is slight.

ANALYSIS OF DATA

The puppet-sessions:

These were analysed before post-test seriation outcomes were considered. They were chosen in terms of the aims discussed here on pages 88 and 89 .

The child's interactions with the puppet were divided into three categories. These were designated respectively: I 'formulation' (f); II 'verification' (v); III 'telling' (t). For each of these features the child was scored on a three point scale determined by his performance in each of the three intervention sessions. The scoring code was as follows:

I 'formulation' (f), this feature referred to the reasons children gave for placing items between the end-squares or for excluding them. Levels of explanation were:

1) the child used descriptive terms such as 'big', 'little'.

2) the child used one-way descriptions even for those items inserted between the end-squares e.g. 'it's bigger' or 'it's smaller'.

3) the child gave appropriate reasons for placing items between the end-elements e.g. 'it's bigger than one and smaller than the other' (the description of three elements with prompts).

For this feature systematic responses to questions about the reasons for inserting the three middle elements determined the score.

II 'verification' (v), this referred to the child's ability to explain to the puppet how it could verify the reasons for inserting elements. Subjects were scored as follows:

1) if the child could give no answer or merely reiterated the reason e.g. 'it's because it is bigger than that one and smaller than that one', or, 'he can know because I tell him'.

2) if the child produced at least three attempts to explain how reasons were judged e.g. 'because I measured it'.

3) if the child made systematic attempts to explain how reasons were judged e.g. 'measure it', 'that one is overlapping' and also told the puppet how to measure e.g. 'put it over one', indicating one end-element, 'put it over the other', indicating the other, then, 'you see a lot of yellow', or, 'you can't see any yellow' (the shape underneath being yellow).

III 'telling' (t), this category was concerned with the extent to which the child could explain the task to the puppet independently of demonstration. Score levels were as follows:

1) the child could not resist pointing to or manipulating the puppet's shapes in spite of instructions to the contrary. When the observer asked such children not to point they resorted to contorted movements with their heads and elbows instead and soon lapsed into pointing again.

2) the child sat back and instructed the puppet without pointing for at least part of the time but this was not consistent. Demonstration emerged at times, particularly in dealing with items that differed in size by very small amounts and where dual relations (bigger and smaller) were being considered.

3) instruction of the puppet was consistently independent of demonstration; the child sat back in a relaxed fashion and gave a full explanation without the necessity of also showing the puppet what to do.

Post-test seriation:

Post-test seriation was analysed in exactly the same manner as for studies 2 and 3.

RESULTS

In order to gauge the child's acceptance of the puppet 'game' it was noted whether he spoke to it and looked at it while answering its questions and whether he appeared to enjoy the situation. All the children except one immediately responded to the puppet by giving it a name and by talking directly to it. The child who did not was reserved in relation to the observer initially but by the second session she had overcome her shyness both with the observer and the puppet. The children were amused by the puppet and when the observer happened to pass through their classroom asked when they were to see him/her again.

Table I (p.98) shows the scores for the three categories of interaction in the puppet-sessions. Table II (p.98) sets out the post-test seriation scores.

The 'puppet' dialogue was the sixth intervention condition to be considered in this project and following the previous system of labelling it was designated condition F. (A = 'action', B = 'dialogue', C = 'didactic', D = 'control', E = 'pairs', F = 'puppet' - conditions respectively). As before comparisons were made of post-test seriation outcomes of these conditions together using the Kruskal-Wallis one-way analysis of variance and of pairs of conditions using the Mann-Whitney U test. A comparison of the six tests together showed there was a significant difference in outcomes between them ($H=18$ df 5 $p<.01$). The puppet-dialogue (F) was not expected to differ in effect from the observer-dialogue (B). This prediction was confirmed ($U=42.5$ $n_1=10$ $n_2=10$ n.s.). Results of comparing condition F with the other conditions individually showed there was no difference between F and A ($U=32.5$ n.s.) but that F did differ significantly from the other conditions (F/D $U=10$ $p<.002$; F/C $U=21$ $p<.05$; F/E $U=21.5$ $p<.05$). All the probabilities quoted here are two-tailed. For all the comparisons just mentioned seriation post-test scores were summed since there was no difference between post-tests I and II as judged by a contrast using the Wilcoxon matched-pairs signed-ranks test (N7 $T=22$ n.s.).

The relation of the puppet-condition interactions to post-test seriation progress is the main interest of this study. In order to test this relationship post-test seriation scores for high versus low scorers for each of the puppet-interaction features (f,v and t cf. p.94) were compared using the Mann-Whitney U test. Scores for f,v and t fell naturally into clear high and low groups about the median in each case. The clearly one-directional nature of predictions allows one-tailed probabilities to be quoted here. Results of these comparisons were as follows:

i) 'formulation' the post-test seriation scores of four children scoring 8, and six children scoring 9 in formulation were marginally significant ($U=4$ $n_1=4$ $n_2=6$ $p=.057$).

ii) 'verification' the post-test seriation scores of five children scoring 3 - 4 compared with five scoring 6 - 9 in verification did show a significant difference ($U=1$ $n_1=5$ $n_2=5$ $p=.008$).

iii) 'telling' a comparison of post-test seriation scores of six

children scoring 3 - 4 versus four scoring 7 - 9 was not significantly different ($U=5, n_1=4\ n_2=6\ p=\cdot086$ n.s.).

Inspection of Table I shows that all children were initially almost perfect in describing the two-way relations of items to be placed ('formulation'). They most commonly scored 3 and occasionally 2. This is to be expected since all these children were selected as able to give the 'three element description' with prompts. Considering this it is if anything surprising that the slight drop in scores of one group from the other should even marginally differentiate them on post-test seriation outcomes. A wider range of competence in 'formulation' would be likely to do so much more clearly.

The data relating to 'telling' in Table I indicate that most children found it difficult to instruct the puppet without at the same time demonstrating what they were trying to explain. However two subjects (b and i) were capable of doing this consistently and it was these children who had the highest seriation scores. Subjects f and h made some improvement in 'telling'. They scored at level 2 in sessions I and II and at level 3 in session III. However of these only subject h scored well in seriation.

The data on 'verification' as seen from the table indicate that half the children tended to find this description difficult or impossible while the other half struggled to invent ways of expressing <u>how</u> they make judgements of difference. Even so none of these 'high-scorers' managed to provide very satisfactory accounts of the way judgements could be verified. In fact all of them were hesitant initially in explaining to the puppet how it could tell what was correct for itself. Examples of some of their solutions are as follows: scoring 1) 'seeing if it were bigger', 'telled it', 'cos I told you', 'it'll be all right', 'cos I know when I was pickin them out'; scoring 2) (isolated attempts not backed up by further explanation to the puppet) 'it looks bigger', 'underneath that looks smaller'; scoring 3) 'if you put it on there you can see something. If you put it on there you can't' indicating placing the insertion shape over the end squares (EL and ES respectively), 'by putting it on and seeing'.

The table shows that there was fluctuation in scoring across the three sessions in the puppet-dialogue rather than any clear change for the better towards the end.

Table I

Scores (1,2 or 3) of 10 subjects labelled a - j for features of the puppet-interaction (f='formulation'; v='verification'; t='telling') in the 3 intervention sessions (I,II,III).

Subjects	f			v			t		
	I	II	III	I	II	III	I	II	III
a	2	3	3	1	2	1	1	1	1
b	3	3	3	3	3	2	3	3	3
c	3	3	3	1	1	2	1	1	1
d	2	3	3	1	1	2	1	1	2
e	3	3	3	3	3	2	2	1	1
f	3	3	3	2	3	2	2	2	3
g	2	3	3	1	1	1	1	2	1
h	3	3	3	3	3	3	2	2	3
i	3	3	3	3	3	3	3	3	3
j	3	3	2	1	1	1	1	1	1

Table II

Post-test seriation achievement for group (F) the puppet-session subjects at levels I,II,III and according to scores of 1 - 8 as before:

	Post-test I Tasks			Score	Post-test II Tasks			Score	Total
Subjects	1	2	3		1	2	3		
a	I	I	III	1	II	II	I	2	3
b	II	III	II	5	III	III	III	8	13
c	I	I	III	1	III	II	I	4	5
d	I	I	I	1	III	II	I	4	5
e	II	I	III	4	I	I	II	1	5
f	I	I	I	1	I	III	I	1	2
g	I	III	I	1	I	I	I	1	2
h	III	II	III	7	III	I	I	1	8
i	III	III	II	7	III	III	III	8	15
j	I	I	I	1	I	I	I	1	2

DISCUSSION

There were three features of the puppet-dialogue which seemed indicative of reflexive awareness, objective reference and detachment from specific actions and objects. These were the categories of 'formulation', 'verification' and 'telling'. The first related to the explanation of the serial relations; reasons why elements were placed in between end-items; the second was justification of these reasons for the sake of the puppet (another); and the third was a measure of how articulate a child was in teaching the task to the puppet. It was thought that these may be regarded as constructive influences to the extent that they relate positively to post-test seriation progress. Of course useful findings depended upon children entering into the puppet 'game'. Evidence of their enjoyment and of the way they interacted with the puppet supplied this necessary assurance. It was also assumed that the puppet interaction was an extension of the same kind of process as that occurring in the observer-dialogue. Indeed the only difference in the nature of descriptions required in the two conditions was the need for more extensive explanation to the puppet and it was hoped that the puppet's inferiority would release any reserve the child might have in talking to the observer. Of course the puppet-dialogue was always preceded by observer-dialogue anyway but it was not thought that this extra amount of discussion would have any effect on outcome or on the nature of the interactions being studied. The fact that seriation post-test outcomes between puppet-dialogue (condition F) and observer-dialogue (condition B) did not differ confirms the main expectations that the puppet condition was an extension of the dialogue with the observer. This allows one to ask how the puppet-interactions clarify the nature of the observer-subject dialogue.

Although Piaget's account of cognitive development does relate cognitive construction both to social interactions and to the organising of events and objects, according to him these are determined by the child's own self-regulations. But if, as he maintains, the whole process is interdependent then such an emphasis is a distortion. Mead reverses the picture and derives objective cognitive detachment from social interactions. It is easy to accuse Mead of a similar though opposite distortion but at least his account is a useful counterbalance to Piaget's theory and seems to provide missing aspects necessary for a full explanation of present findings. Features of the

process occurring in the present asymmetrical dialogue suggest that no one particular aspect is predominantly effective. In the dialogue the child's reflexive communications are directly concerned with his growing understanding of serial relations and the one is positively related to the other. Evidence from the puppet study shows: 1) that children who 'formulate' the appropriate descriptions prompted by the puppet are those who make progress in seriation; 2) that children who were beginning to explain how judgements can be verified ('verification') by the puppet were clearly discriminated as those who made most post-test progress. Perhaps the first point does no more than endorse the idea that asymmetrical dialogue (condition B) guides the child to formulate appropriate references. By itself this finding seems to support Piaget's stress on self-regulative processes which are assisted by the observer's closely dove-tailed responses. But it is particularly interesting that 'verification', which is evidently only just emerging in these children should be so significantly related to seriation competence at post-testing. This finding suggests that a reflexive pull is exerted by the dialogue interaction which may well have a strong effect upon the construction of objectively verifiable relationships. This seems to indicate that it is the shared meanings expressed in the dialogue which are especially important in the process being observed. The meanings are negotiated consensual references and it may be that their influence is exerted actually as they are forced into explicit form by the need to express them to another from that other person's viewpoint. The role-taking involved in this process may indeed bridge cognitive and social functions and in Mead's terms 'significant symbols' are being formed in this way. But at the same time each individual has to be sufficiently free to express for himself each step in the negotiated meanings; self-regulation and social adjustment formulated in communicative speech determine cognitive progress. This is implied by the significant relationship of 'verification' and 'formulation' to progress in seriation here. But it was also thought that as the shared meanings involve common and objective reference another index of this communicative influence would be the ability to explain a task without at the same time demonstrating it. This kind of detachment was labelled 'telling' here but although two children (subjects b and i) who did best in post-test seriation were those who were able to explain the task independently of demonstration, overall

test of the group did not prove a significant relationship of this kind. Thus no conclusions can be drawn about this feature of the puppet dialogue. It is tempting to speculate that children of this level of understanding are still too deeply embedded in the need to act out their reasoning for such detachment to become as yet a significant influence of speech upon understanding. But alternative explanations cannot be ruled out. The task lends itself to demonstration although the two effective subjects (b and i) show that it can be explained independently if one is sufficiently articulate. Another consideration is the possibility that individuals of all ages naturally differ in the way they express themselves in speech, some being more demonstrative than others. Cursory observation of adults suggests that this is so in anycase whether or not there is also some developmental feature related to communicative efficiency.

It remains to consider whether the observation of the puppet-dialogue as an ongoing form of directed learning has shown up qualities of that process comparable to those considered in the studies of Inhelder et al. (1974). Firstly the influence of their learning situations upon post-test progress was very similar to that found here both for condition B (dialogue) and F (puppet). Children did make progress but it was gradual and tended to be spasmodic. In the Genevan learning situations the children were confronted with paradoxical problems. The Genevan group attribute post-test progress to the child's resolution of these paradoxes. They do not consider the fact that discussion between observer and child was an integral part of the situation. Present findings suggest that it is not just the engagement with a problem that expedites thought but also the reflexive and guiding influence of talking about it with another person which matters. Intermediate children in the Genevan group were noted for their inventive pseudo-solutions. These seemed to be unsuccessful attempts to synthesize relations. The same may be said of children in this study. They were gradually resolving the necessary relations of series and how to explain these appropriately. Their attempts to explain 'verification' to the puppet were inventive but only partly successful but this attempt to express the basic justification of the relations seems to relate strongly to post-test seriation progress. Present findings confirm the nature of the learning processes as observed in the Genevan study but also show effective features of dialogue intrinsic to it which are entirely

overlooked by Inhelder et al. (1974).

The puppet-dialogue has shown that an important component of communication and reference taking place in the asymmetrical discussion is the role-taking. This reflexive influence forces the child to adjust to other points of view. Of this the most striking indicator was the process of verification which depends upon shared meanings. These meanings are agreed by the dyad in the solution of the problem; they are agreed references. The next study will consider the essential nature of this referential use of speech which is effective in the dialogue.

Chapter 6

REVERSIBLE OR REFLEXIVE REFERENCE

The study to be described in this chapter (study 5) considers speech, not in its communicative role but in the way it is used for reference. Two aspects of reference are compared in order to see which produces most progress in seriation. These are implied in the title of the chapter. Both occur in dialogue but they have not been distinguished from each other in the dialogue intervention tasks which have been used so far. The first, reversible reference, concerns the underlying meaning or message of serial relations which is conveyed through the speech. The message which the child gradually distils out of his discussion with the observer is a unit of apparently opposite relations in the particular dimension concerned. This opposition of relations determines the position of any item within any series, whether it be size, hue, weight or shading etc. To date only the dimension of size has been used for discussion. The message of the descriptions 'bigger and smaller' is the reversible difference of each item to its neighbours and could equally well be expressed in a shaded series in which case the appropriate description would be that an item is inserted in the series because it is blacker than those on one side of it and whiter than those on the other. The reversible unit of relationships is the same as for the size series and if the message is what matters for producing seriation progress then intervention discussion which conveys this message irrespective of the dimension concerned will produce progress in seriation. Because intervention dialogue in the studies used so far has centred round size relations only it is not entirely clear that the referential influence is mainly concerned with the reversible relations just outlined. Perhaps instead the use of comparative constructions, such as 'bigger/smaller', or even 'smaller/blacker' increases reflexive attention in the child and thus helps him to consider and to hold in mind alternative perceptually visible differences. In this case the construction or form of the speech marks dimensional differences which are thus selectively perceived by the child. These two distinctions about speech reference may be summarized as follows:

1) Reversible reference occurs as speech is used to resolve the underlying relationships of the seriation problem. In this use it enters into the construction of serial understanding; its main function is to mediate the message of that problem and in this sense it may be

said to have a 'direct' influence in cognitive construction.

2) Reflexive reference refers to the possible influence of comparative speech constructions or forms upon selective attention. The forms reflexively direct attention to perceived dimensional differences. This may be considered a relatively 'indirect' influence of speech upon cognitive construction.

Results so far suggest that the 'direct' influence is the most effective one but in order to confirm this, 'direct' and 'indirect' conditions must be separately tested. Arguments in favour of the 'direct' influence lie in the fact that the dialogue intervention which has effect on seriation progress consists in a sequence of mutually negotiated formulations. What is agreed upon is determined by the nature of the problem as both participants see it at each turn in the discussion and what is understood to be true is a matter of the specific end in view at the time. In this 'game'* reference has no fixed object attached to a particular verbal construction. Meanings are changing as the discussion progresses towards resolving the problem. Forms of utterance are less important than their applications. This point is further emphasized by the fact that the 'verification' feature of the puppet-discussion was strongly associated with post-test seriation progress. The child's attempts to verify size relations to the puppet had no fixed verbal format but they were most concerned with explaining the underlying relations of series.

Piaget does not believe that the surface characteristics (the syntax) of language have much to do with cognitive growth. For him, as also for other workers such as Sinclair-de-Zwart, logical constructions evolve primarily through the child's active adaptations. In the course of these adaptations speech may be useful in revealing the meaning of any particular task: it carries the underlying message which enables the child to reflect upon it and to become aware of his own thinking (Piaget 1974a). Polanyi (1962) writes of the transparency of language. He distinguishes the tool, being the linguistic form, from its use, being its meaning. Sinclair-de-Zwart as discussed previously believes that the logic of seriation is attained in understanding the reciprocal reversible relations which are epitomized in the

* Wittgenstein (1958, 1972) uses the idea of the meaning of a word (its reference) being built up through the 'games' or circumstances of its use. In the final chapter here this idea will be discussed in terms of Austin's (1962) notion of reference.

'three element description'. Learning the description itself does not achieve this. The difficulty children have in learning it reflects the operational logic it represents. But Piaget's thought in 1974 has begun to take a new turn which is in line with Polanyi's notion. Like Bruner (1973 and 1975) he is beginning to emphasize the role of speech as a reflective medium. Piaget has maintained all along that speech emerges in the service of the child's exploratory activities. What the child says indicates his present understanding and as that understanding changes so does the reference. In this sense Piaget writing in 1974 admits that spoken reference can become a medium of reflection which can assist thought. But Piaget still believes that the mainspring of cognitive growth is the equilibration process based on self-regulated activity. It is this process which underlies the development of reversible thinking; thinking which can be turned back on itself and recomposed. For him the child's own adaptations or self-regulations move towards stable systems of thought. Obviously the most stable system of relationships for understanding an ordered series is one which includes the reciprocal aspects of difference of each item (the three element description). This notion allows the thinker to work effectively with any form of series; it has general application and it is a reflexive notion. In Piaget's terminology it is 'reversible'. Clearly there are degrees of reversibility. Children who tend to use notions of 'bigger' or 'smaller' rather than just 'big' or 'small' are becoming more flexible in their understanding of series than previously but it is only when they appreciate the double relation of each element that they can reflect across and within series with perfect freedom. For Piaget it is the equilibration process which leads to this; the child's own adjustments in terms of changing ends. These ideas, if applied to the present studies suggest that the message underlying discussions about insertion of items in ordinal series will affect understanding much more powerfully than the forms of speech which frame it. It is reversible thinking mediated in the speech which is finally synthesized by the description of any kind of double relation in an ordinal series which defines and stabilizes the thought system. This message resolves the problem neatly and understanding will for present purposes be completed. Because it is a finalising and flexible unit of thought it will be particularly compelling regardless of the kind of series in which it is represented e.g. size, 'bigger and smaller' or shading, 'blacker and whiter'.

In her 1967 work Sinclair-de-Zwart suggested that language had only a minimal effect upon cognitive development. But she did admit that small advances which occurred after 'verbal training' might be attributed to improved selective attention. She appeared to mean that the appropriate use of apposite forms of speech guided the child's choice of alternatives in constructing a series or in judging amount. This effect she thought was particularly clear in seriation because relations of a series are perceptually evident and can thus be easily matched to the description whereas amount of liquid quantity cannot be so easily described. Inhelder and Sinclair-de-Zwart (1969) discussed this point:

> the seriation experiment is different from the conservation experiment, in that conservation is never visible by itself whereas relations in a regular series are perceptible and allow a description that, in a sense, is an exact replica of the result of the operation. (ibid p.18).

This idea which suggests that syntactic features of speech can be mapped onto perceptible configurations is only thought of as a peripheral and indirect influence upon the growth of understanding by the Genevan group and thus of little consequence. But Bruner's original stand in 1964 and that of Bruner et al. (1966) suggested that speech forms had a central constructive influence. David Olson (1970) has elaborated this idea. He used a variety of training conditions designed to teach young children to produce a diagonal line of dots on a checker-board or of lighted bulbs on a board of electric bulbs. Olson says that the diagonal idea is a conceptual construction which can thus be generalised as an aspect of intelligence. Results of his training conditions showed that 'instructional training' was effective whether it was 'verbally mediated' or not. Instruction consisted in pointing out the salient choices to the child. It was this selective feature which seemed effective and verbal training which did not include it was ineffective. From this he seems to suggest that cognitive development (intelligence) is determined by the medium of operation (the speech) provided that it directs the choice of appropriate perceptual alternatives.

He says:

> The elaboration of the perceptual world that occurs under the mastery of performatory acts in various cultural media is responsible for the development of what is usually called intelligence. Both the acts of speaking and comprehending an utterance require for their mastery information based on the

> selection of cues that were otherwise irrelevant hence undetected.... the perceptual world is elaborated in the context of mastering performatory skill in the medium of language. (ibid p.202).

However the 'selective' feature which Olson thinks is the heart of the constructive influence operates only in situations where communicative interactions occur. For instance ineffective verbal training appears to be purely didactic and that which is effective evidently contains discussion. 'Instructional training' without verbal components is clearly a matter of interactions between observer and child conveyed in gesture in Olson's experiments. He feels that the nature of the task partly governed by the medium in which it is undertaken determines selection of cues from the perceptual world of the child. This seems to overlook the functional and communicative role of language or gesture and allows him to retain the gulf between language form and function which Bruner now, (1973, 1975) and Piaget (1974a) are beginning to dismiss. Thus Olson maintains the idea that the form of language can have a central selective influence upon cognitive construction. Olson's theory emphasizes this influence whereas Sinclair-de-Zwart and Inhelder regard it as minimal. But there is no clear evidence to show whether indeed speech is a transparent vehicle for the underlying message or whether the forms of speech play an important part in structuring cognition.

Study 5 attempts to distinguish the influence of speech forms from their underlying message in the development of seriation. In Piagetian terms one may ask whether seriation is advanced by the child discovering reversible relations with the use of speech or whether the comparative constructions which describe such relations act as a major catalyst in themselves. Both influences probably play some part in the development of understanding but Piaget's view is that the message carried by the speech and incorporated in the activity of solving the problem is central to cognitive development whereas the speech forms are peripheral to it. Previous findings in this project do more than endorse this idea for they suggest that communication with others is part of the referential function effecting cognitive progress. The effect occurs as the child formulates for others the message of the problem he is resolving. But intervention conditions used to date have not distinguished effects of the form of description from the reversible message which it carries. Here, two conditions which isolate these features are compared for their effect upon post-test

seriation competence. They are:

1) the reversible reference condition (direct): The message applicable to any ordinal series is the double relation of each item to those on either side of it. This is a double and opposite relation, thus in the size series elements have their unique position because from those above they are smaller and from those below they are bigger. The same serial message is contained in a shaded series where items are placed because they are blacker than those on one side and whiter than those on the other. For the 'direct' condition children were given exactly the same insertion task as in all previous intervention conditions except that items had to be placed in a shaded series. All the items in this series were the same size. Post-testing as before consisted in the covered-set size seriation tasks. In this 'direct' condition descriptions and perceptible features were not the same as those contained in the post-tests, only the reversible message which defines series was the same in both.

2) the reflexive reference condition (indirect): the form or construction which marks perceptible differences e.g. comparative terms (bigger/smaller, smaller/blacker) may produce a reflexive effect upon the child's attention to differences in various dimensions. In order to test this influence independently of the 'reversible message' of seriation children were asked to insert items which were serially ordered in both size and shading in a similar insertion task as before. But here elements to be placed between 'end-items' had to be described as both 'smaller' than one and 'blacker' than the other. In this 'indirect' condition the intervention provided experience in using varied comparative terms applied to dimensional differences but which did not contain the 'reversible message' which defines series in general. They were merely two differences concerned with two different dimensions which could be perceived by the child. Post-testing was the same as in other tasks, the covered-set size seriation tasks. Thus intervention and post-testing both contained perceptible size differences marked by the apposite comparative terms and in addition other comparative terms matched to other perceptible features were given the child as intervention.

METHOD

Design

Two groups of children were selected and matched at pretest for the same operative and descriptive criteria as in studies 2, 3 and 4. There were 13 children in one group and 12 in the other. In the first group (I) there were 6 boys and 7 girls, in the second group (II) 6 boys and 6 girls. The mean chronological age and range for the first and second groups respectively was 5.7 years, range 8 months; 5.7 years, range 7 months. The same sequence, timing and procedures were followed here for tests and intervention tasks as previously. Intervention tasks differed only in ways relating to the hypotheses contrasted above. Thus group I children were given training in the essential logical message of seriation irrespective of particular perceptual features; they were trained in seriating shaded differences and tested in size differences. Group II had practice in attention to differences in shading and size using the appropriate comparative terms, e.g. 'bigger/smaller' and 'blacker/whiter'. Group II children were also tested in size seriation tasks as were all other groups in all cases.

Intervention tasks

The first task which was given to group I was designated the 'direct' (logical) intervention because it was concerned with the dual relations of items in any kind of series irrespective of appearances. The second task which was concerned with the influence of comparative terms in directing attention to alternative differences was designated the 'indirect' (attentional) intervention.

Materials

For both tasks materials were flat discs cut out of card and backed with sand paper. A plywood board 3 feet long and 1 foot wide covered with pink brushed nylon provided the working surface for the tasks. As the shapes were not coloured but only shaded in degrees from black to white the colour of the board provided a pleasing contrast.

For the 'direct' intervention materials were:

i) for demonstration, 6 circular discs all the same size. Each disc was 6 cms in diameter and the set was graded in degrees of white to black. Two of the shaded discs were marked with a red star between which two of the others should be inserted if an ordinal

arrangement was made. One disc was white and another was black. These it was obvious did not go between the starred items if a shaded series was to be achieved.

ii) for the insertion task there were 9 squares with sides measuring 6cms two of which were starred. These also were graded ordinally in degrees of white to black as were the circular discs. Three of these squares were of intermediate shading to the two starred items, two were too white to go between them and two were too black to do so.

For the 'indirect' intervention materials were:

i) for demonstration, 9 circular discs each different in size and also graded in degrees of black to white. Thus this one set represented ordinal series in both shading and size. The smallest items were most white and the largest were most black. The diameter of the discs were each respectively: 2½cms, 5cms, 6cms, 7cms, 7½cms and 8cms. There were extra items, one of each of the following sizes and shades: 2½cms, black: 6cms, almost black; 6cms, entirely black. The 5cm and 7½cm discs were marked with a red star each.

ii) for the task, there were 9 squares graded both in size and shading in the same way as the discs described above. The sides of each square respectively measured: 2cms, almost white; 5½cms, a little darker; 6cms; 6½cms; 7½cms; 8cms; 8½cms; 9cms and 10cms. The last square was black. The 6cm square and the 8½cm square were marked with a red star each. There were one each of extra squares with side measurements and degrees of shading as follows: 2cms, black; 5½cms, almost black; 6½cms, almost black; 7½cms, almost black; 8cms, almost black.

Procedure for the intervention tasks

For the 'direct' intervention task: the procedure followed was exactly the same as that of the size insertion tasks of the dialogue condition B of study 2 (cf. p.54). Children easily described the shaded differences as 'whiter or blacker' but they had the same difficulty as previous subjects in explaining why elements should be placed between end-squares e.g. 'because it is whiter than one and blacker than the other'. This of course was the 'three element' description and involved formulating the dual, reversible relationship which epitomizes any ordinal series. As before in all cases the task was initiated by demonstrating the procedure using the set of circular

discs and then children were required to place each square between starred end-squares as they drew it from the bag or to discard it if it was not appropriate to insert it.

For the 'indirect' intervention task: the demonstration set was arranged in front of the child, horizontally as in all previous insertion tasks, and the child was asked to notice that the discs were different in size and also in degrees of blackness or whiteness. The rules of the game were explained in exactly the same way as in all previous tasks except that here in the discussion the child was led to observe that inserted items were smaller than one starred disc and blacker than the other one. The child learned to notice size in relation to the larger/blacker starred item and shading in relation to the smaller/whiter one. Children quickly learned these rules for inserting squares between starred items. These end-squares were placed in front of them as in other tasks and as in all previous insertion tasks items for insertion were drawn from the 'secret bag'. This game was enjoyed by the children as much as any of the other insertion tasks and provided a considerable amount of practice in noticing differences both in size and in shading. Unlike the 'direct' task, for the 'indirect' task size differences were evident and seriation post-testing concerned size. Occasionally children did make a double comparison in size e.g. 'its smaller than one and bigger than the other' instead of 'its smaller than one and blacker than the other' as the game required but this happened on only one or two occasions and was easily corrected by the observer. The game was maintained as a dialogue by asking the child to decide whether an item should be inserted between end-items or not and to explain why in terms of the differences 'smaller and blacker'. Children had no difficulty in doing this. Because the purpose of this intervention was not to discuss reversible relationships but instead to emphasize perceptual differences the 'reversal procedure' was not included in this intervention task. This did not mean that the 'indirect' task was shorter than the 'direct' one since there were extra items which had to be placed for the 'indirect' task. These items were added to ensure that children had practice in making all possible exclusion and inclusion judgements e.g. items could be included for one dimension but excluded for the other, or they could be excluded for both (size and shading). They were placed between end-squares provided they could be included for both.

RESULTS

The scoring for post-test seriation competence was exactly the same as that used in studies 2, 3 and 4 (Tables I and II p.113 give these data. As before comparison of post-tests I and II using the Wilcoxon matched-pairs signed-ranks test showed no difference ('direct' condition, H T=5.5,N=8,n.s. This difference for the 'indirect' condition, G was negligible, cf. Table I p.113). Thus for both conditions post-test scores were combined and results of the two conditions were compared using the Mann-Whitney U test. This showed that there was a significant difference in outcome in favour of the 'direct' condition (H) ($U=35, n_1 12, n_2 13$ $p<.02$, two-tailed).

A comparison of the seriation outcome of all eight conditions of intervention used in studies 2 - 5 was made using the Kruskal-Wallis one-way analysis of variance. This confirmed the significant difference previously noted in the other studies ($H=33.5$ df 7, $p<.001$). Individual comparisons between conditions G amd H respectively with each of the other conditions were made using the Mann-Whitney U test. These are set out in Table III below.

Table III

Results of comparing post-test seriation outcome of conditions G and H respectively with each of the other conditions using the Mann-Whitney U test.

Conditions	A (action)	B (dialogue)	C (didactic)	D (control)	E (pairs)	F (puppet)
G (indirect)	U=42 n.s.	U=15 p<.02 G<B	U=57 n.s.	U=50 n.s.	U=56 n.s.	U=23.5 p<.02 G<F
	(for all these comparisons $n_1=10, n_2=12$)					
H (direct)	U=51.5 n.s.	U=50 n.s.	U=32 p<.05 H>C	U=25 p<.02 H>D	U=32.5 p<.05 H>E	U=60 n.s.
	(For these comparisons $n_1=10, n_2=13$)					

All the probabilities quoted are two-tailed.

Table I

Post-test seriation achievement for group G - the 'indirect' condition.

	Post-test I Tasks				Post-test II Tasks				
Subjects	1	2	3	Score	1	2	3	Score	Total
1	I	I	I	1	I	I	I	1	2
2	I	I	I	1	I	I	I	1	2
3	I	I	I	1	I	I	I	1	2
4	I	I	I	1	I	I	I	1	2
5	II	I	II	2	I	I	I	1	3
6	I	I	I	1	I	I	I	1	2
7	I	I	I	1	I	I	I	1	2
8	II	II	I	2	I	I	I	1	3
9	I	I	III	1	I	I	I	1	2
10	III	I	I	1	I	I	I	1	2
11	I	II	I	1	I	I	I	1	2
12	I	I	I	1	I	I	II	1	2

Table II

Post-test seriation achievement for group H - the 'direct' condition.

	Post-test I Tasks				Post-test II Tasks				
Subjects	1	2	3	Score	1	2	3	Score	Total
1	II	II	II	3	III	II	III	7	10
2	I	II	I	1	III	II	II	5	6
3	I	I	I	1	I	II	I	1	2
4	II	III	II	5	I	I	II	1	6
5	II	I	I	1	I	I	I	1	2
6	I	I	I	1	I	I	I	1	2
7	II	I	I	1	II	II	III	5	6
8	I	I	I	1	I	I	I	1	2
9	I	I	I	1	III	II	II	5	6
10	I	I	I	1	III	III	II	7	8
11	I	II	II	2	I	I	I	1	3
12	I	I	II	1	II	I	III	4	5
13	I	I	I	1	I	I	I	1	2

DISCUSSION

The comparison of two kinds of reference has given clear results in favour of the 'direct' condition. Speech, it seems, is most effective if it is used directly as a tool to extract the serial relationships which characterise series in general regardless of perceptual dimensions. This is consistent with previous findings. For instance, discussion about the problem (condition B) has proved more effective than just learning the appropriate descriptions (condition C). The cooperative process of dialogue forces participants to alter their references in terms of changing ends as they gradually solve the problem together. They negotiate the references. Perhaps it is this process of adjusting to the shifting use of speech which is partly responsible for cognitive growth? Moreover participants in a discussion must innovate and the feature of discussion with the puppet which was most strikingly linked with seriation progress (verification) particularly required the child to do so. Discussion entails negotiation, formulation and innovation. The speech which expresses these processes must consist in varied utterances with shifting references. Thus although in line with Olson's theory the use of comparative terms may be thought to exert a reflexive influence upon the child's attention to perceptual features of the insertion task and so produce progress in seriation, it seems more likely that speech influences thought at a more fundamental level and this prediction has been endorsed. The reflexive influence of speech forms (indirect reference) is secondary to the role of speech as the means of expressing the serial relations themselves (direct reference).

The main result to support this prediction is the significantly better outcome of the 'direct' condition (H) than the 'indirect' condition (G). Condition H gave the child no experience with <u>size</u> relations, only with the reversible differences of series in general, yet it was clearly more effective in producing progress in size seriation tasks than condition G where perceptual features were available to the child. This finding supports the argument that speech is most effective as it is used to extract the content or message of the serial construction, a construction which can be made in any set of dimensional differences. Speech is in fact here a part of the problem solving process and not some extrinsic influence upon it. All the other results of comparisons fall into place in terms of this

explanation. The overall comparison of conditions confirms the differences already established. Individual comparisons provide some indication of the way this difference occurs. Inspection of Table III(p.112) reveals the broad picture; that conditions B (dialogue), F (puppet) and H (direct) are relatively effective in producing progress in the understanding of serial relations whereas the other conditions are not. These effective conditions all consist in dialogue and all contain direct reference to the relations of items in series. Of most interest to the present study is the fact that condition H is just as effective as conditions B and F. Both of these conditions were concerned with size series which was the same perceptual dimension as the post-test tasks, yet discussion about the same relationships in another dimension (shading) had as much influence on size seriation tasks. In condition H speech has effected cognitive development in terms of the formal relations of series despite perceptual differences in the intervention and post-test tasks. The effective conditions (B, F and H) support three important aspects of the process of cognitive construction. These are: innovation, negotiation and direct reference to the central and formal properties of series. The first two (innovation and negotiation) occur in dialogue. The third (direct reference) is made available to the child by means of the guidance in the dialogue with the observer which allows direct reference to the content or message of the problem. A combination of the three features is lacking in the ineffective conditions. For instance: condition D (control) denies all three; condition C (didactic) lacks innovation and negotiation and although it contains the direct reference the child himself cannot make use of it unless he is free to innovate and to negotiate; conditions E (pairs) and G (indirect) contain the necessary means to negotiate through discussion but neither type of discussion leads the child to formulate the direct message; condition A (action) denies the child the opportunity to negotiate with 'another' and even if he can discover some of the message for himself he lacks direct reference formulated in speech. But the main result of study 5 shows that speech is an important feature of cognitive construction if it can be used as a tool for detecting the meaning or message of a problem. This use permits reflection upon one's own solutions and those of others. By this means speech has a constructive influence in cognitive development.

Chapter 7

FINDING OUT

This project has been a journey of discovery which in itself is concerned with the child's discoveries; how he finds his way from the known to the unknown and how uncharted territory becomes sufficiently familiar for him to travel in any direction without losing himself (the development of reversible thinking). The central aim has been to see how the child's use of speech influences his discoveries.

The course undertaken here was to explore the child's discovery of seriation and it seems quite clear that this problem involves the child in breaking new territory as he explores for himself. Only gradually does he begin to grasp the idea of a series as a general structure and each step in this conceptual journey remains a mystery to him until he has solved it. In this sense information only serves as the child himself comes upon it in his search. However the main finding of the present empirical studies is that the child resolves his problems best by explicit spoken negotiations with an experienced person. This enables him to explain and understand his solutions which can thus be seen from a general viewpoint. This is the role that language plays in cognitive development.

This thumb-nail sketch indicates the line of argument to be developed in this chapter but first the analogy of exploration will be used to frame some necessary appraisal of the project. A journey has an envisaged destination and ways of reaching it have to be invented. It is important to map the route. At the outset this and the nature of the destination remain to be discovered. Then it is quite likely that the end of the journey leads to further goals and the traveller also realises the need to retrace his steps in order to consider the route in more detail.

These ideas suggest ways in which one should reflect upon the initial goals, the methods, outcomes and conclusions of an empirical dissertation. For instance one must reappraise the main purpose of the study; was it a significant problem in the field or did analysis prove it to be spurious? Was it a practical issue and was it essayed in a valid manner? Finally, if reasonably satisfactory answers to these questions are given, how far did results provide an answer? One explorer's journey is unlikely to result in a definitive map of the route and other ways of travelling and other routes to the same goal

should provide a useful source of comparison. Indeed the traveller may need to reconnoitre the way ahead still further since he may not have reached the destination he intended. He may see that divergent courses lead from his destination. In this chapter there will be an appraisal of the problem and its engagement, a brief résumé of the route taken and findings on the way. Finally these discoveries will be coordinated for interpretation in terms of a general theoretical context.

APPRAISAL OF THE PROBLEM AND METHOD

These considerations have previously been discussed in chapter 1 thus only a short summary will be given here. The problem as it presented in 1972 was the subject of a major controversy in the field of developmental psychology. Present findings and those of other researchers have not dissipated its theoretical significance. Essentially, this is because a better understanding of the role of language in cognitive development must reveal more about the nature of both these features of development. Moreover cognition and language are fundamental human capacities. In fact one cannot deny that the problem is epistemological. Even if one is not prepared to be drawn into the philosophical aspects of it, to ignore this may lead to inconsistencies in theorizing. For instance, Bruner (1964) and Bruner et al. (1966) tried to maintain an uneasy balance between empiricist and interactionist views on the influence of language on cognitive growth. Language was seen as an extrinsic shaping influence whereas the understanding which it shaped was conceded to be a complex <u>evolving</u> system (cf p. 7 chapter 1). This seems to have contributed to the emphasis on the structure of language as opposed to its use which obscures real issues in development. Besides being fundamental to developmental psychology the present problem is a consideration which bears indirectly on practical issues such as education of normal and handicapped children. In this sense present findings may guide the choice of appropriate questions to be answered by further research in these areas.

From the start it was clear that the problem expressed as 'the role of language in cognitive development' must be analysed. Then some central feature of this broad notion could be chosen which might

be amenable to research. In the past hypotheses making general claims left 'language' and 'cognition' as undifferentiated processes. Thus repeated experiments have given paradoxical results. Barbara Lloyd (1972) points out that the linguistic-relativity hypothesis of Whorf and Sapir (1956) is based on the influence of lexicon on perception and memory. Linguistic influence upon logical development may be quite another matter. Indeed it is important to specify some particular area and stage of logical development in order to avoid confusions. This in turn must lead to the choice of tasks which are appropriate in content and in difficulty for the specific feature of cognitive growth which is chosen. This point was overlooked in the work of Oléron (1957) and Furth (1966) which Piaget (1970a) quotes in support of his case. In the event the most promising entry for this project seemed to be at the transition to logical operations already explored by Bruner (1964) and Bruner et al. (1966) and Sinclair-de-Zwart (1967) who was attempting to contest Bruner's stand. This provided a specific point to study in cognitive development in a logical problem, that of seriation. The fact that Sinclair-de-Zwart had noted some progress in seriation consequent upon language training suggested that here there was an effect to investigate even though Sinclair herself dismissed it as insignificant. Her grounds for doing so were: 1) that it was relatively small; 2) that practically no advance had resulted in similar circumstances for conservation of continuous quantity. She assumed that the better seriation outcome was due to the perceptual configurations which are easily matched to their descriptions in series. To her this meant that language thus became an operational exercise, or that linguistic forms direct attention to perceptual features. She favoured the first supposition. The second she thought was minimal (cf. pp. 25,26 and 106). But she did not test these alternatives. Clearly there was a problem to be investigated here. Moreover it concerned a specific aspect of cognition and related to a specific point in development. The assessment of the understanding of conservation in the child is known to be fraught with difficulty partly because it depends upon the child's spoken judgements (cf. Peill, 1975), but the measurement of competence in seriation of the kind intended by Piaget was possible using Woodward's (1974) covered-set tasks. And in this case descriptions could be separated from an assessment of competence in the task. The validity and reliability of these tests in Piagetian

terms is discussed in chapter 1 along with other views on the nature and measurement of seriation. Here it is sufficient to reiterate the view that these tasks seem to capture the behaviour of children who are gradually learning to coordinate and synthesize the skills which mark an understanding of the essence of series in general - the dual relations of each element to those on either hand in any series. Moreover, seriation is chosen because it seems to be a central feature of human understanding. This is Piaget's view; that it is one among the operational structures which are universal logical entities. His account of the quite independent discovery by the Bourbaki school of the same structures as the axiomatic bases of mathematics lends credence to his view (Beth and Piaget, 1966; Piaget 1970b). In a general sense ordination is a universal and basic way in which man deals with his environment even at a very elementary level. In chapter 1 some criticisms of Piaget's developmental theory were discussed. The main objection to his scheme was the idea that children are far more rational at an early age than he would admit. This has suggested either that intellectual capacity is preformed, or that it is almost entirely dependent upon learning. In the first case it is regarded as innate, in the second case the whole of mental construction is thought to derive from information provided by the environment. Both of these ideas suggest that one should be able to elicit reasoning of an adult kind by giving the child the appropriate opportunities in sufficient quantity. It also seems to suggest that reasoning is a general process since it can be released by or built up by any kind of learning or information at any time. In other words, if it is innate and only needs releasing by experience, what is thus freed is a general reasoning power; or if it is all learned, then what is accrued is just added together regardless of order, content or amount. Piaget's theory suggests that the quality of thought changes in the course of development although the processes of construction are always the same. Thus only appropriate experience can be used by the individual at any one time. The process is one of adaptation. The individual constructs his own thought systems from the food of experience and what he uses from his field of experience depends upon his current needs. This makes all the difference to the way one interprets children's behaviour at different ages. For instance it is not sufficient to demonstrate that three year old children can nest cups in series as proof that they are

therefore in possession of the same inferential capabilities as children of six or seven years. In Piaget's system the 3 year old is organizing items in a simple practical way aided by the perceptual features of the task. He is quite unable to appreciate the relations of items in a series which will enable him to add an extra element in any covered set. Competence in this task suggests that he has coordinated reversible and general formal features of series; a complex capability which has taken 3 or 4 years more to achieve. However, in this connection there is one further criticism of Piagetian tests and their assumptions which has been made recently (McGarrigle and Donaldson, 1975) and this must be considered before the present work is outlined and discussed. McGarrigle and Donaldson have shown, in studies of children's conservation of number and length, that fewer children conserve when the observer alters the configuration of elements than when this occurs 'accidentally' because a 'naughty teddy' 'messes up' the arrangement. They believe that this suggests that children may be able to conserve earlier than Piaget's tests would imply. 'These results give clear indications that traditional procedures for assessing conservation seriously underestimate the child's knowledge' (ibid. p.347). According to them this is because the child is really trying to interpret the observer's intention instead of his/her explanations. Thus the children focus their attention on the perceptual change effected by the observer because they believe this is what is intended even though spoken instructions do not indicate this. This leads the children to make non-conserving judgements because they think this is required of them and not because they do not understand conservation. The fact that 'naughty teddy's' misdemeanour is so easily discounted shows, according to McGarrigle and Donaldson, that children can indeed conserve. But nice as this argument may seem it can easily be turned on itself. McGarrigle and Donaldson took pains to discount teddy's act as a mistake. Indeed some children did try to rectify it. Although they were discouraged it is clear that the children took the cue that what he had done was not part of the game. Why then should the children not make 'apparent' conserving judgements? The tendency would be for them to consider the first matched arrays of items which had been seen and agreed to be equal in number. What teddy had done with these items was neither here nor there. If this is the case this was not a test of conservation, for the children were relying on their

memory of the two matched sets which were perceptually the same. However, there is no reason to doubt that children do try to read the observer's intentions through what he/she does as well as what is said especially if the spoken utterances are in the least ambiguous and this is the main lesson that McGarrigle and Donaldson draw from their findings. In fact Donaldson and Balfour (1968) have shown how the words 'more' and 'less' are comprehended synonymously by young children. The whole point is that conservation of amount rests on children's spoken judgements and their comprehension of the observer's questions. Piaget tried to minimise this effect by giving children a variety of questions and counter suggestions. For instance if the child gives a non-conserving answer he will be told that another 'little girl/boy' took the opposite point of view. He will then be asked again to make a judgement of amount. This was to ensure that each child had every opportunity of hearing both points of view and was as far as possible enabled to express his real understanding. Donaldson and McGarrigle make no mention of the use of such counter suggestions. If they did not use them then the observer's actions are likely to remain the focus of the child's attention and this would result in a non-conserving judgement whether the child could conserve or not. The fact remains that there is no way of distinguishing the real understanding of conservation of amount irrespective of perceptual transformations and the way that they are effected. This point is made by McGarrigle and Donaldson. But they do not emphasize that in their experiment the 'naughty teddy' situation could very easily lead to spurious conserving judgements whereas the 'observer' situation might tend to lead to the opposite (spurious non-conserving judgements). As mentioned above, the impression they give is that Piagetian tests underestimate the child's understanding. This is a separate matter which is not shown by their experiment whereas theirwork does show just how difficult it is to distinguish children's understanding in terms of their spoken utterances and their actions. However in the present investigations this is exactly what had to be done otherwise it would be impossible to make any progress in understanding the role that speech plays in cognitive development. Post-test seriation tasks rested on children's actions and not their judgements and the observer always tried to give every opportunity for children to make as many comparisons as they thought necessary in order to be sure they knew the right place to

insert the extra rod. Of course the intervention conditions deliberately varied the observer's approach as an experimental variable. One may say that here the child was encouraged to read her intentions and the subsequent effect upon competence in seriation was studied. In fact the purpose of the whole project is to investigate the role of language in various communicative situations upon cognitive development. Until 1974 Piaget (1974a, 1977, 1974b) dismissed this question. But, as will be discussed later, he has begun to concede that speech may be a useful reflective agent. Bovet (1975) has shown that schooling among Africans (adults and children) is a significant factor in the acquisition of conservation and notions of time. This is in line with Greenfield's previous work (1966) with Wolof children. Thus there is a very clear case for considering the role of explicit communication in conceptualisation. What has been discovered in connection with this problem in the present studies will now be briefly summarised and the picture of results as a whole will be discussed in the general theoretical context as it stands today.

SUMMARY OF STUDIES

This project contains 5 studies all concerned with the role of speech in the acquisition of seriation of children between 5 and 6. The present summary of these studies will be confined to indicating the salient questions and answers relating to each. Appraisal of the results of each study will not be undertaken at this stage unless particular interpretations have led to the formulation of succeeding studies. A short consideration of method and a general appraisal of outcomes as a whole will follow.

Study 1 (Heber, 1977) was based on the seriation language training experiment of Sinclair-de-Zwart (1967). It was directed at the practical question of whether learning the appropriate use of the descriptions 'bigger/smaller' would affect progress in seriation, especially among children initially inefficient in the use of this description. The design of this study laid the pattern for all those that followed. It consisted in selecting children and matching groups at pretest for competence in seriation; in providing different kinds of speech intervention afterwards on three successive days; and post-testing in seriation one day following and again two weeks

later. All subjects at all times were tested and trained individually. In study 1 children were selected for two matched groups as being 'preoperational' and 'intermediate' seriators, but one group were initially able to describe rods in an ordinal series appropriately using the terms 'bigger/smaller', the other group were not. The first group of 20 subjects were middle class, the second group of 20 were lower working class. Each group was divided into experimental and control groups of subjects (10 in each group). The latter had no intervention but did have the pre- and post-tests in seriation. It was assumed that if there were any influence of speech on the acquisition of seriation this would be relative to initial descriptive competence. In other words, if speech is a major influence in cognitive development it should produce progress where it is supplied to subjects who lack its proper use. Those who initially use descriptions appropriately will not show this influence of speech training because the effect should have taken place already. However, these rather simple assumptions did not take account of the fact that the descriptions concerned are used in a particular context; speech is a part of the seriation tasks. Indeed the results were not as straightforward as the first assumptions suggested. Rather they indicated that speech was affecting cognitive growth by some interactive influence. They were as follows: 1) experimental subjects in each group (MC and LWC) performed significantly better than controls in post-test seriation tasks; 2) the children who had initial descriptive competence improved in post-test tasks immediately. They were both significantly better than when they started and they were also significantly better than the descriptively less competent group at the first post-test although all children had learned the appropriate descriptions during the three training sessions; 3) the descriptively less advanced group took longer to learn the descriptions within the three sessions but they gained the same amount of seriation competence as their 'confrères' at the second post-testing; 4) these two patterns of advance(immediate and delayed) occurred in each control group respectively although to a significantly lesser degree; 5) the quality of progress for most children consisted in making small sequential advances towards a more efficient performance. These were called one-step moves. Only very few children advanced more rapidly and none became clearly operational according to the criteria set. It was noticeable that initial descriptive competence exactly matched the kind of progress made in seriation, i.e. the kind of description that the child could

give appeared to relate to the kind of seriation feature in which he subsequently improved. Thus children who could describe ordinal series in both orientations e.g. 'going up they are getting bigger, going down they are getting smaller' made progress in ordering the loose sets of rods but did not improve in the covered-set insertion tasks. The few children who could initially describe B in relation to A and C where A>B>C, made progress in the covered-set tasks. This apparently close liaison between initial repertoire of descriptions and prompt and apposite seriation progress suggested that speech interacts with cognitive processes at the particular point of development to which the task relates. Thus training in speech use triggers advance towards operational conceptualisation. On the basis of this interpretation further studies were designed in order to discover the nature of this interaction. In order to focus at a clear point of conceptual transition among subjects most likely to show immediate effects, for all subsequent studies children were selected who could initially give the 'three element description' with prompts and who were also 'intermediate' seriators. For these subjects seriation tests were confined to the covered-set insertion tasks as being most apposite to their descriptive and operative level of competence.

Studies 2, 3, 4 and 5 investigated the manner in which speech enters into the process of cognitive change by selecting the most constructive combination of conditions in which it operates. Broadly there seemed to be two combined operative factors, on the one hand the communicative use of speech and on the other its precise application or referential use in the seriation tasks. In study 1 intervention consisted in the child learning to use descriptions of serial relations appropriately in dialogue with the observer. It seemed likely that dialogue was a major influence in cognitive progress but alternatives considered were: learning the descriptions without discussion and without action; and the child's activity in constructing series without the aid of descriptions. Children were not allowed to manipulate the elements in the intervention task of study 1 but incipient imagined action cannot be precluded. In order to test whether speech in dialogue was more effective than other likely modes of intervention for study 2 four groups of 10 children were selected and matched on the criteria described above (they were 'intermediate' seriators and could give the 'three element description'

with prompts). They were then compared for the effects of different modes of speech intervention upon progress in seriation. The intervention conditions were as follows: A ('action' condition) children did an insertion task without describing what they did; B ('dialogue' condition) the insertion task was accompanied by discussion with the observer of the kind which occurred in the intervention of study 1; C ('didactic' condition) the child learned the description while he watched the observer explain and demonstrate the insertion task. He was encouraged to recite the description with her; D ('control' condition) children only received the pre- and post-test seriation tasks at the appropriate times. They had no intervention tasks. The intervention task in this and all subsequent studies consisted in asking the child to find elements which could be correctly inserted between two end-items in an ordinal size series. In studies 2, 3 and 4 the items were flat discs differing in size and in study 5 discs both different in size and shading were used for one condition. But for a second condition of study 5 serial differences were in shading alone, not size. For all the intervention tasks circular discs were used first for demonstration but for the task itself the discs were squares. Except in study 5 the task consisted in placing a large and small square beside each other in front of the child. He was then asked to withdraw others one by one from a bag and to decide which items should be placed between the end squares and which were too big or too small if ordinal sequence were maintained. End squares contrasted in colour from the items which had to be placed. The model arrangement of circular discs which had first been used to demonstrate the task to the child remained in front of him for reference. The demonstration set of discs for the 'shading' condition of study 5 only differed in degrees of whiteness or blackness, not in size, as did the squares used for the task of this condition. For all these studies pre- and post-test tasks were size seriation covered-set insertion problems.

Results of study 2 showed a significant difference in post-test seriation competence between groups. As there was no difference in outcome between post-tests I and II for any of the conditions results of post-tests were summed for making overall and individual comparisons between groups. Results of these comparisons showed that the difference between groups was due entirely to the dialogue condition (B). All the other conditions including the control were not significantly different from each other in outcome. Thus the communicative

function of speech evidently plays an important role in the acquistion of the understanding of serial relations.

Since the dialogue in study 2 was between the observer and the child this communicative influence could be due to the observer's experienced guidance in eliciting appropriate descriptions from the child, or, on the other hand the reflexive nature of the discussion might in itself be the effective component of change. Study 3 tested this contrast by selecting 5 pairs of 'intermediate' seriators on exactly the same criteria as in study 2. Child pairs did the intervention task and discussed their solutions together. There was plenty of discussion about which squares to place between end-elements and also a large measure of disagreement which the children had to resolve between them. However their post-test seriation competence was not significantly different from the control group, action and didactic condition groups of study 2. The dialogue condition of study 2 remained significantly more effective than all the others. This result suggested that discussion with the observer led the child to produce an apposite and objective formulation of the problem. In order to study this formulation process more closely the next investigation (study 4) aimed to make the child express his solutions even more explicitly. In order to produce this effect study 4 intervention consisted in asking the child to teach the insertion task to a glove puppet after he had first discovered how to do it with the observer. There were 10 children in this group selected and matched aspreviously. High post-test seriation scorers discriminated significantly from low-scorers by the fact that in teaching the puppet they were those children who could easily describe B in relation to A and C where A>B>C. But most interestingly, although they found it difficult to justify and explain this description to the puppet it was children who could thus find ways of verifying their judgements who were significantly better at post-test seriation. There was a tendency, not significant ($p=.086$), for best seriators to be able to explain the task to the puppet <u>without</u> demonstration. Although this feature of the puppet-dialogue might relate to articulate detached conceptualzation, evidence for this was lacking. In anycase it could also show just an individual characteristic way of giving explanation.

Aspects of the puppet-dialogue which most closely related to seriation competence at post-testing were the child's reference to and justification of the relations which determine insertion of items in a series. It was the content of the speech and not its form which

seemed effective. Therefore study 5 considered whether this 'direct' referential use is indeed the core influence or whether the structure of descriptive utterances have an 'indirect' effect in shaping thought. In order to make this comparison study 5 contrasted two matched groups of children for the influence of 'direct' and 'indirect' conditions of reference. Selection and pre- and post-test criteria were exactly the same as before. There were 12 children in the 'indirect' condition group and 13 who received the 'direct' condition intervention. The 'indirect' condition was based on the assumption that the use of comparative terms such as 'smaller/blacker' used to refer to perceptual differences may have the effect of directing the child's attention to alternative differences. Thus he will become more flexible in his thinking and make comparable progress in seriation tasks which follow. This is in line with Olson's (1970) theory which was developed from that of Bruner et al. (1966). Moreover recent interest in linguistic analysis (Chomsky, 1968, McNeill, 1970, Sinclair-de-Zwart, 1967) has led to the assumption that speech forms (syntax) can have a formative influence upon thought. In contrast, for the 'direct' condition it is assumed that the underlying message or content of the speech is the major influence on progress in seriation. This message distils the relations of <u>any</u> series whether consisting in size differences or shading or any other dimension. Thus the children given the 'direct' intervention had an insertion task in a <u>shaded</u> series in which the items did not differ in size. As for all other groups post-testing consisted in size seriation tasks. This 'direct' reference condition proved to be significantly more effective than the 'indirect' condition and confirmed the indications of study 4 that the child's understanding progresses as he formulates the meaning of a task. In this case the meaning consists in the double and opposite relations of difference which enable him to insert items in any kind of series effectively. These relations lie at the heart of cognitive construction and not their perceptual features or the forms of description which mediate them.

Overall comparison between conditions differentiated those which were relatively effective in producing progress in seriation and those which were not. Those which were effective were all conditions containing dialogue and all contained direct reference to serial relations which the child must formulate himself. They were: condition B, dialogue with the observer; condition F, the puppet-dialogue;

and condition H, the 'direct' reference condition. All the other intervention conditions did not differ in effect from the control group D which had no intervention at all.

In study 1 subjects were all boys. Practical exigencies led to the inclusion of both sexes in about equal numbers in all the later studies. In order to check that there was no difference between the progress of boys as opposed to girls a comparison of their relative progress was made using the Mann-Whitney U test. This was done separately for groups who made progress and for groups who did not. Thus boys from the dialogue and puppet groups were compared with girls from the same two groups. There was no difference in their seriation post-test progress ($U=146.5$ n.s., $n_1=10, n_2=10$). Also boys from the control and didactic condition groups were compared with the girls from the same two groups from their post-test competence. Here also boys did not differ from girls ($U=46.0$ n.s. $n_1=10, n_2=10$).

CONSIDERATION OF METHOD

All the studies of this project follow the same design; pre-testing for selection of subjects, experimentally varied intervention and subsequent post-testing. The aim is <u>to study the processes</u> which occur in cognitive development particularly in relation to speech. They are <u>learning</u> studies as distinct from training studies. The aim of training studies has been largely concerned with expediting the child's development for educational purposes (Bereiter and Englemann, 1966). Here there is no attempt to hasten the child's cognitive growth. Instead the procedure attempts to discover which kinds of intervention containing speech are most consistent with the way that development occurs best in normal children. The child's development is thought of as an organismic process which is indivisible. In terms of Systems Theory one cannot assume that there are separate causes and effects, only that certain features of the ongoing process work together towards a more complex equilibrium and others are alien to this. Effective conditions permit cognitive processes to resolve themselves into new and more effective systems of understanding. However Inhelder and Sinclair (1969) following Piaget (1964) stress that careful account must be taken of the child's initial cognitive level in a learning study, using several tests and allowing the child

full opportunity to express his considered judgements. Post-testing should contain all the items of the pre-test and should be checked for durability. All these injunctions are followed in the present work and if anything criteria used here are more consistent and precise than in the Genevan studies. The Genevans also suggest that tests of transfer to other fields of thought should be given. (Modgil, 1974, reviews these questions). Clearly the scope of this project has not extended to studying transfer effects, but cognition and speech have been determined by detailed and consistent criteria at pre- and post-testing. This was based on video recorded data in all cases after study 1. For study 1 all sessions were sound recorded. Study 1 stands on its own as a separate experiment. Those which follow (studies 2, 3, 4 and 5) are in effect one experiment. Not only is the design exactly the same throughout but also criteria for selection and for judging seriation competence. On these grounds comparisons between groups of the different studies seemed justified. Thus an overview of effective and ineffective conditions provides the opportunity to detect the interacting features of cognitive growth and speech.

INTERPRETATION OF RESULTS AS A WHOLE

The findings of study 1 indicated that speech is an effective influence upon progress in seriation especially among subjects already primed with the appropriate descriptive uses. The fact that speech intervention had been conducted as an open dialogue between observer and child suggested that this communicative condition was at least partly responsible for the progress that was made although the content of the dialogue naturally could not be dismissed. Studies 2, 3 and 4 variously analysed the nature of this communicative influence and study 5 isolated the nature of the effective speech content. These results suggest the following conclusions:

The notion that there is a problem which can be resolved in terms of 'language' and 'thought' has to be dismissed. Both concepts are too broad to have any meaningful application at any particular point in development. Moreover all such practical issues relating to cognitive development of young children concern the influence of speech in particular contexts. Anything other than a specific and

pragmatic approach to the issue is unlikely to be useful. Conclusions must be kept within these confines.

The fact that an immediate and significant amount of progress in seriation occurred among subjects who already had the appropriate descriptions available seems to indicate a close interaction between speech and cognitive operative change. This is further endorsed by the fact that the kind of progress made closely matched the kind of description currently available to the child; a lag in either speech or in understanding serial relations seems to take time to produce concurrent change (e.g. LWC group of study 1). The child may perhaps be resolving for himself the general orientation and configuration of rods in an ordinal set. If he already has means of describing these features he can quickly operate with them to clarify the immediate issue. Other descriptive uses such as the 'three element description' serve no purpose for him until he begins to grasp the exact and decisive relations of each element in the series. This possible interactive operation will be discussed again later.

Although it is inappropriate to consider piecemeal cause-effect relations in a project such as this one (cf. p.84 chapter 5) the intervention procedures have high-lighted conditions which coincide with cognitive change and those which do not. There is consistent evidence that speech is an effective component of cognitive construction only if it is mediated through dialogue (dialogue condition B). This dialogue allows reciprocal adaptation and negotiation to take place between observer and child. The child gains little by just learning the descriptions (didactic condition C) and little enough when he works out serial relations for himself without talking about them to someone else (action condition A). Even if he does talk to someone else mere contention which may make him aware of other viewpoints is not by itself sufficient for him to construct new levels of understanding (pairs condition E). He must create the particular unit of relations which make up the logic of ordinal series and this he does best by negotiation with 'another' who can guide him. Plausibly, if he has exercise in attending to any variety of perceptual differences matched to comparative terms, the form of words and the reflective exercise will promote his ability to sift serial relations at post-test ('indirect' condition G). But apparently, in this task, where logical relations are at issue, the child utilizes the speech to grasp these relations directly ('direct' condition H) regardless

of perceptual features. Speech becomes an extension of his logical understanding. This in gist is the overall interpretation which can be drawn from the studies in this project.

The nature of the progress made by the children has been discussed in chapters 2,3 and 5. The use of video recording for studies 2 onwards allowed detailed observations of speech and action to be made. This revealed that the children who were selected as 'intermediate' seriators who could describe the 'three elements' with prompts had at their command all the features of action and speech which should enable them to make the appropriate 'double comparisons' in the 'covered-set' tasks, but they did not do so. What was lacking? It appears to be the understanding of the double relation of each element as a unit which is the essential general feature of all series. The progress which occurred after effective conditions such as B, F and H (dialogue, puppet and direct reference) showed the children becoming systematic in the double comparison use. Following the other conditions this use was sporadic and not sustained. Moreover the analysis of effective discussion in the puppet study shows that effort to grasp, not only the logical relations of B to its neighbours, but also the objective verification and meaning of this relation, was associated with advance in seriation. These observations and findings together should begin to provide some answer to what occurs between speech and cognitive understanding that bridges the gap between a loose agglomeration of skills and their effective synthesis as a logical unit of thought.

THEORETICAL CONTEXT

The only studies which have direct bearing on present findings are those which can be interpreted in terms of the interaction of two concurrent uses of speech; its use for reference to the cognitive problem currently being resolved and its use for explaining and negotiating this formulation to others. The first may be called the 'referential use' the second 'the communicative use'. Bruner (1964) and Piaget (1970a) Sinclair-de-Zwart,(1967) Inhelder, Sinclair and Bovet(1974) have gone directly to the question of speech in problem solving at the critical transition to concrete operational thinking. As discussed in chapter 1 Bruner was contesting the Genevan viewpoint.

But although both proponents were dealing with the role of speech in context of ongoing problem solving at the most likely juncture for this influence to become critical to cognitive growth neither side explicitly emphasized the combined importance of communicative and referential use. But from the present stand these implications are easily read in their findings. Sonstroem's (1966) training studies in conservation of quantity revealed advances towards operational conservation where the child's own actions were combined with verbal 'labelling' but not where these two conditions occurred independently of each other. However, as has been discussed in chapter 1, Bruner's interpretation at that time was concerned with the idea of language as an extrinsic shaping influence upon cognition. What they call 'labelling' must have developed through some form of discussion between observer and child which clarified to the child his actions in 'manipulating' the clay used in the conservation problem. These studies (Bruner et al. 1966) were somewhat concerned with outcomes at post-test and did not sufficiently analyse the processes inherent in the conditions they were varying. But it is interesting that Bruner (1973) has now explicitly turned his attention to ongoing processes, using video recording techniques. The link between communicative and referential use is now being forged when he writes of 'the ontogenesis of speech acts' (ibid). Thus he seems to be developing the implications of his 1966 studies at their source.

The Genevan 'directed learning' studies were instigated to contest Bruner's challenge (1964). These were that of Sinclair-de-Zwart (1967) and Inhelder, Sinclair and Bovet (1974). They have been discussed in this dissertation in chapters 2 and 5 respectively. In chapter 5 this work was contrasted with the present puppet study and it was clear that although the same amount and type of progress occurred in their studies as that which followed dialogue conditions in the present project the Genevan group attributed children's progress solely to the work of solving problems in the learning situations they were faced with. This explanation dismisses the role of speech entirely on the basis of Sinclair-de-Zwart's claim that 'verbal learning' is of no consequence in cognitive development. The Genevan group seem to take 'verbal learning' as an extrinsic syntactic influence in the same way as Bruner et al. (1966), although of course Bruner's group regarded its influence as important. Thus both schools of thought overlooked the possibility that speech interacting

in referential and communicative use lay at the heart of the progress they observed. In the Genevan learning studies children solved problems in discussion with the observer. Sonstroem's (1966) combined 'manipulation' and 'labelling' conditions may well have contained what amounted to discussion about the task. However, although the interpretations given by each school fall short of looking at their findings in terms of a possible synthesis of communicative and referential use in speech there are intimations in their writings that begin to suggest this opening. For instance, Inhelder and Sinclair (1969) commenting on Sonstroem's study make the following points.

In the first place they admit that Sinclair-de-Zwart's findings (1967) must be regarded as tentative in regard to the role of language in cognitive development; that progress between substages although almost always fairly limited, does become 'fairly frequent if verbal training is combined with operational exercises' (Inhelder and Sinclair, 1969 p.18). Thus they are not surprised at Sonstroem's results but dismiss Bruner's interpretation. Bruner, (Bruner et al. 1966) as previously discussed (p.6) believed that symbolic representation harnessed to the enactive mode, overpowers misleading cues given by the iconic, or perceptual mode. The Genevan account is quite different. They say:

> operational exercises imply meaningful action on the part of the child ("action" does not necessarily mean manipulation of objects); it is the feedback from these actions that brings about operational progress. Verbal training designed to make the child acquire patterns used by children who are already in possession of the operation in question, results (if it succeeds) in conscious use of appropriate language - and let us not forget that speaking also is a form of action. Such action can reinforce the feedback from the other coordinating actions performed by the child, especially in the case of an operation of which the result can be described in a way that is very similar to the operation itself. (ibid. p.18).

They add the point already discussed in this thesis that Sinclair-de-Zwart found children had difficulty in learning the 'three element description', a difficulty which she considered to be operative rather than linguistic.

> ...the difficulties encountered by the subjects in the learning of certain expressions seem to be of the same nature as the difficulties encountered in the acquisition of operations; an incapacity to decentrate and coordinate. Therefore linguistic structures do not seem to be acquired uniquely according to

> their own laws ... an operational component is necessary before linguistic structures, acquired in isolated sentences, are ready to be generalized and correctly applied in all situations. (ibid. p.19).

The points in these two quotations which have special interest here are: the reference to 'meaningful action' which apparently can be manifested in spoken rather than motoric form; the reference to 'the conscious use of appropriate language'; and the idea that manipulative and spoken activities operate by feedback processes. But the conclusions remain in the Genevan tradition, that linguistic structures emerge from a generic cognitive root (cf. also Piaget and Inhelder, 1969, pp. 52-54 and 89-91), and learning difficulties are something to do with 'incapacity to decentrate and coordinate'. The implications of these notions will be developed later. For the present it is perhaps sufficient to suggest that their combined significance must lead one to admit the importance of speech in cognitive constructive processes. But to do this it is of course essential to see that speech is not an external shaping influence. Instead it is part of problem solving. It can become part of the individual's reflective activities as he organizes objects in relation to each other assisted by conversation. Bernstein (1973), who admits his indebtedness to Mead (1934) , has emphasized the social and referential functions of language. Schlesinger (1971), Fillmore (1968) and Bloom (1970) all independently express the need to study the influence of speech functions as also have Donaldson and Balfour (1968), Donaldson and Wales (1970). Recently Donaldson (1977) has underlined this point by discussing experiments which show that children respond to the salient features of a task despite spoken instructions. A similar finding has already been described (McGarrigle and Donaldson, 1975) on page 120 of this chapter. They also found (Donaldson and McGarrigle, 1974) that children who were asked whether there were more or less toy cars on each of two shelves answered correctly if the cars stood free but if they were enclosed in 'garages' children responded in terms of how many garages were full irrespective of the number of cars on each shelf. Donaldson and McGarrigle suggest that children interpret instructions in terms of, as they put it '"local rules" ... since they determine a kind of "local meaning" for the language' (Donaldson, 1977 p.294). She summarizes her arguments by suggesting that converging evidence

indicates that the transition from rigid egocentric thought to reversible conceptualisation is largely due to 'the emerging ability to respond with close attention to "the meaning" of utterances even when this meaning is an unexpected one, not supported by the context in any way' (ibid p.295). But she adds that the child's "emerging ability" depends upon whether he 'realises that responding with close attention to linguistic meaning is the appropriate thing to do' (ibid). Thus she seems to be suggesting that children work with the language in the particular referential and social context and gradually derive its general acontextual meaning from both sources.

The main area where both uses are being studied together is in Bruner's recent work which has already been mentioned at various points in this thesis (Bruner 1973, 1975, 1976). He is particularly struck by the importance of considering different levels of language use, which, based on analyses of Austin (1962), Silverstein (1975), Grice (1968) and Searle (1969) concern two combined functions of utterances, the illocutionary (communicative) use and the locutionary (referential) use. Influenced by Ryan's (1974) suggestions he points out that the mother interacting with her child in various 'habitual exchanges' (Bruner 1975), negotiates mutual communicative intentions. In these early communicative exchanges between mother and child he suggests that children gradually learn how to cope with reference:

> What adults do for the child is to teach him or help him to realise how these taxonomic procedures operate in assuring joint reference in relatively well established situations ...(ibid.p.13).

Of course this work of Bruner's does not indicate the influence of speech in logical development but if the roots of linguistic use and of understanding the world lie in the social action context then early manifestations of logic may be similarly affected. This is what the present findings suggest. Other similar trends in theory are the growth of interest in social development. This is discussed by Schaffer (1974):

> It is often said that the study of early social behaviour lags well behind the study of early cognitive behaviour ... but it is becoming increasingly difficult to make this classification. This is partly because of the interest in subjects like language development which seems to belong to both categories and partly because of an increasing tendency to blur the distinction between the two fields and concern oneself with, for example, cognitive processes underlying social behaviour or the social context of cognition. (Schaffer, 1974 p.209).

In the present project all the effective conditions contained dialogue yet also permit the child to resolve serial relations in his own way. Here social and cognitive factors are clearly functioning together and it seems to be the force of communicative negotiations which bring about the 'conscious, reflective use of speech' (Inhelder and Sinclair, 1969 quoted here on p.133). Social influences help to determine consistent judgements.

Present findings lead one to extract the common ground between the two apparently opposing lines of thought namely, Vygotsky (1934/62), Luria (1961), Mead (1934), Bruner (1964) on the one hand, and Piaget's views from 1926 onwards, on the other. Although both sides have to admit the child's initial incompetence in verbal communication, once speech is mastered their views on its role in the development of thought have differed. For Vygotsky 'speech structures mastered by the child become the basic structures of his thinking' (Vygotsky 1962, p.51). Piaget suggests that, 'language is moulded on habits of thought', and 'that a child is not actually conscious of the concepts and definitions which he can nevertheless handle when thinking for himself'. (Piaget 1926/59 p.79). Vygotsky does not deny evidence of thought before language is mastered by the child. Indeed Bruner, who followed and developed Vygotsky's line of thinking is now much inclined to trace conceptual development along with 'speech acts' as previously indicated (p.132). Both Piaget and Bruner are interested in the idea that speech becomes detached from action. Piaget in this regard, dismisses the influence of the public sign-system of language. Rather, it is the child's own individual use of means of representation which has this constructive effect: 'The semiotic function detaches thought from action and is the source of representation' (Piaget and Inhelder, 1969 p.86). Probably conscious reflection which is possible by means of explicit reference to action assists this detachment process. But present findings lead one further than this indication from Piaget. Perhaps, as Shotter implies (cf. p.86) 'meaning is a logical construction to be completed both by oneself and one's listener out of the influences exerted by one's utterance'. However, Shotter feels that in terms of social interaction Piaget neglects the importance of 'intentions' (Shotter 1974, P.220). Certainly in relation to cognitive development the importance of 'intentions' seems an unavoidable issue. This notion is an attempt to characterize that gap between 'known' and 'unknown' often spoken about as the child's

growing 'awareness'. But Piaget has never neglected this. His whole theory is concerned with it even if his emphasis has played down the role of social influence. Piaget speaks of operative thinking as flexible: 'flexibility in hindsight is a direct function of flexibility in anticipation ... recognized by the fact that a child can put into operation a plan which is more or less complete'. (Inhelder and Piaget, 1964, p.216). Donaldson quotes Piaget (1974a) writing of 'La prise de conscience' as the growing awareness which can occur at all different levels of development; the process of conceptualization which develops towards 'an enduring awareness' (Donaldson 1977, p.296). She goes on to interpret Piaget as follows: 'If we apply this to mental acts then "stopping to think" and talking about our thinking would be critical for progress'. (ibid. p.297). But Piaget (1974a/1977) does not stress the importance of the communicative aspect of this talking. Shotter does so; for him the 'meaning' of an utterance emerges from the negotiations inherent in the dialogue where mother and child come together to frame social 'targets' (systems of rules). Taking this point as part of the total picture, the child's awareness will consist in gradually appreciating the point of view of others in regard to the task in hand by means of guided spoken discourse. For the present project the task consists in understanding relations which to the philosopher and mathematician are axiomatic. But somehow, in the course of development these apparently veridical relations are <u>gradually constructed</u> both by the individual himself and also by consensus.

This discussion of theory shows that the opposing views on the role of language in cognitive development (Bruner, 1964; Sinclair-de-Zwart, 1967, Piaget, 1970a) seem poised to converge. Bruner is now concerned with the way 'speech acts' emerge as part of the social context of the family (1973, 1975). Piaget is now drawing attention to the idea that conceptual development may partly depend upon <u>explicit</u> reflexive processes (1974a/1977, 1974b), although he still seems to overlook the <u>communicative role</u> of speech in this process. Before elaborating on these changing views the trends of thought which may have contributed to their near convergence will be considered. Finally there will be an attempt to interpret present findings in terms of one point of synthesis.

THE INTERACTION OF SPEECH AND COGNITION: WHAT IS THE PROCESS?

Bruner is referring to Austin's (1955/62) ideas when he writes of the 'ontogenesis of speech acts' (Bruner 1973). These ideas expand notions of linguistic meaning beyond mere reference to objects (Russell, 1905; Frege, 1952). They are more in line with Wittgenstein's suggestions that the meaning of words 'is built up through the circumstances or "games" in which the word is used' (Bates 1976 p.8). This line of thought supports the idea that it is most useful to study speech function in particular contexts if one is to discover its role in cognitive growth. Austin's William James lectures (1962) set out the thesis that there seem to be 'performative' speech uses and also utterances that are 'constative'. The former refer to how one is using speech, the latter to an utterance as descriptive or referential; a pure proposition. The former may be evaluated as felicitous or not, the latter by their truth or falsehood. But this account implies that these are separate categories of speech whereas they are only different attributes of all utterances. Thus Austin gradually dissolves this apparently clear distinction and comes to the conclusion that there are no pure 'constatives'. All speech is performative. Speech is always an activity which can vary in kind. Whenever something is said, even if there be no immediate listener, the utterance carries with it social implications such as the entailment of consistency or not. This leads Austin to state his General Theory of Speech Acts and the performative/constative contrast is subsumed within it:

> The doctrine of the performative/constative distinction stands to the doctrine of locutionary and illoctionary acts in the total speech act as the special theory to the general theory. And the need for the general theory arises simply because the traditional 'statement' is an abstraction, an ideal, and so is its traditional truth or falsity.' (Austin, 1962, Lecture XII p.147).

Austin's General Theory suggests that speech as action has three overlapping characteristics or features; the locutionary being the content of an utterance; the illocutionary being its intended communicative use; and the perlocutionary being its actual communicative effect. All speech acts may be accounted for in these three ways. But the idea that pure statements along with their truth value do not exist in practice is consistent with present findings that seriation logic is constructed by the child most effectively in negotiation with 'another'. The veridical is best established by consensus.

Austin appears to confine the meaning of illocutionary force to commonly agreed uses such as the words of the marriage ceremony or naming a ship. These are speech acts which provide extra explicit meaning to some performance which it would not otherwise have. He does not include oblique communicative uses which suggest a double meaning which are referred to by Watzlawick et al. (1968). Nor is he referring to poetic uses such as allegory or metaphor. For present purposes the idea that speech is a kind of action is extremely interesting. It is relevant to the findings of this project that Austin sees speech as necessarily communicative:

> Once we realise that what we have to study is not the sentence but the issuing of an utterance in a speech situation, there can hardly be any longer a possibility of not seeing that stating is performing an act. Moreover, comparing stating to what we have said about the illocutionary act, it is an act to which, just as much as to other illocutionary acts, it is essential to 'secure uptake'': (ibid. Lecture XI p.138).

'Securing uptake' appears to refer to the negotiatory aspect of speech which must of course occur in dialogue.

Bruner's interest in 'speech acts' is consistent with the movement away from the study of grammar and syntax (Chomsky, 1965; and McNeill, 1970) towards semantics (Fillmore, 1968; Schlesinger, 1971). Schlesinger draws attention to the inadequacy of a purely syntactic model for explaining language acquisition:

> A speaker does not produce just any utterance, but an utterance which he finds appropriate in view of the situation at hand ... In short, the speaker has certain intentions which he realises in his speech. (Schlesinger, 1971, p.64).

He continues: 'There is no place for intentions in a grammar, but any theory of performance which fails to take intentions into account must be considered inadequate'. (ibid. p.64). He thinks semantics has been neglected because it is a difficult field of study:

> Psycholinguists have therefore concentrated on syntactic models, trying to show how the child acquires abstract sentence forms, and have let the sense take care of itself. Yet it is not very plausible that the child should learn to produce empty structures which he subsequently stuffs with meaning. (ibid. p.85).

Although this contention refers to language acquistion at an early stage the role of speech in the acquisition of logical structures may well follow a similar course. In other words the resolution of logical relations is likely to be closely linked to learning the appropriate

speech uses. Thus the fact that Bloom (1970), Greenfield and Smith (1976), Bates (1976) Macnamara (1972), Cromer (1974), Nelson (1973), Edwards (1973) and Sinclair-de-Zwart (1973) all tend to place cognitive processes as prior to language acquisition is not easily dismissed here. But it is Bloom's contention that the child evolves his comprehension and production of speech within the context of action which bears most closely on present findings. Greenfield et al. (1976) show how part of the speech act is gestural and related to the immediate situation. They maintain that the child's first words are best interpreted as only one aspect of the child's action in the relevant context rather than as 'holophrases'. For the term 'holophrase' has been used as a loose conjecture that the child is attempting to convey undefined whole sentences in single word forms. But where an utterance can be analyzed in relation to the situation in which it occurs along with the accompanying action, it may be seen that the child presupposes much that is given in that situation and by the action. He merely adds a speech marker by way of communication. Greenfield et al. referring to performatives say:

> The earliest Performatives are on the borderline of language proper. These examples lack complete separation of word and referent and are part of the child's own nonverbal action ... For example, the greeting hi is first part of the act of waving; later it functions as a greeting without a wave. (Greenfield and Smith, 1976 p.83).

The position that these workers are now adopting is increasingly close to that of Piaget. For Piaget describes the development of semiotic processes as an adjunct to action; they manifest accommodative imitation (Piaget, 1962). The child's early imitative activity is a kind of representation which is eventually marked by or extended by spoken utterances. These utterances develop idiosyncratic and rather general associations appropriate to the child's present interpretations; words seem to be identified with their notional activities (Piaget, 1962; Piaget and Inhelder, 1969). This is the position which other workers cited above are now confirming. It consists in a pragmatic view of speech emerging and operating within the context of the child's activities. Utterances thus index and communicate the meaning of the activity to some extent. Although the total significance of that activity is not embodied in what the child says, the 'illocutionary' and 'locutionary' force of his utterance may extend and clarify the meaning of the action both to a listener

and to the child himself. This communicative and reflective influence is likely to be minimal initially but the indications are that it is much more powerful at the margin of logical understanding in the child. In early instances an utterance may be merely a marking flourish that brings an action into focus for the attention of others and the child himself. This may isolate and clarify a particular experience. Later the utterance is used to recall this experience out of context; detachment from particular instances begins. Bruner cites this kind of example from his current research (Bruner and Sherwood, 1976). For the present study it is interesting to look for increasingly detached formulations which arise out of the problem solving activity of seriation tasks. This will be enlarged upon when an overall interpretation is discussed.

The trend of current research and theory which relates to the child's cognitive and linguistic development is pragmatic (Greenfield and Smith, 1976; Bates, 1976). The child is studied as he develops in his natural setting. But current studies improve on the early diarists (Stern and Stern, 1928) by being more systematic and consistent. Piaget has always tried to learn from the child's behaviour observed in some natural context and it seems likely that this approach leads to a primary interest in the child's actions. As Greenfield and Smith (1976) have recently noted, the child's utterances fit into his action sequences, they do not seem to determine them. Piaget's observations have led him to consider that the child's own self-determined actions by which he adapts himself to his surroundings are in a practical sense, the way that the child thinks. Thought and behaviour are indistinguishable. In early instances the child's action is a function of an immediate goal but the means and ends tend to be confused and evanescent. If language is seen as simply an extrinsic social sign-system, then neither its formal nor its social influence can have any part to play in the self-modifying system which Piaget envisages. Speech can only operate in the context of the child's own activity, indistinguishable in effect from the understanding process itself. In fact Piaget's theory of semiotics expounded in 1951 (Piaget, 1962) takes this line. 'Language' is left aside as if it were an additional influence which in its formal sense plays no effective part in cognitive development. Only at the stage of formal operational thinking is its influence conceded. Joanna Ryan (1974) indicates the importance of Piaget's pragmatic approach to semiotics

but also stresses the need to attribute more force to the social influences which Piaget tends to overlook. She draws support for her ideas from linguistic philosophers such as Austin (1962) and she also cites Strawson (1959) because she is interested in the idea that early social development involves knowing how to operate as an individual among others. This idea cannot be overlooked at any level of adjustment to 'reality' whether it be understanding serial relations, which is to do with relations of objects, or whether it is to do with personal relations of 'I' and 'you'; my point of view or yours; the understanding of deixis. In this project a combined influence of social and objective viewpoints seems to be required to produce progress in understanding seriation. Thus the present contention is that if the abstract formal notion of language is set aside and if instead speech is recognized as operating in the context of the child's activity, then it can be dovetailed to the processes of cognitive development which Piaget believes are fundamental. But there is no need to relegate communication to a peripheral role. On the contrary it is integral to the emergence of formalized knowledge.

In two recent works (Piaget, 1974a/77, 1974b) Piaget discusses the role of reflective processes in conceptualization. He finds from his observations and discussions with children doing various tasks that they are often proficient in action before they can explain what they do and how they do it. However the whole tenor of the work leads him to recognize explication as at least one means to coordinating relations and understanding new unified relational structures on a representational plane. He is inclined to the view that understanding seriation mainly derives from action but he takes account of Sinclair-de-Zwart's suggestion that 'verbal learning' can in this instance become 'an operational exercise' because the relations of series are easily perceived in the size differences between rods. This is perhaps a beginning towards recognizing the importance of communicative and referential use of speech in problem solving but Piaget does not appear to make the necessary distinctions which would clarify the nature of the process by which it may become effective in developing 'conscious awareness'. The vestigial view of speech as just an extrinsic sign-system remains and is dismissed as before. He discusses conceptualization without pointing out the fact that children necessarily explain their concepts by speaking. Moreover as with Inhelder, Sinclair and Bovet (1974) Piaget accounts

for progress in thinking without taking account of the fact that throughout his learning studies and those of Inhelder et al. children are being asked to discuss their judgements with the observer. Piaget is giving an account of conceptualization which admits the role of explication without also admitting the importance of the dialogue which is a necessary part of it.

Since 1951 at least Piaget has aimed to outline conceptual development in the child. It seems to go without saying that this involves movement in the child's thought from tacit 'know-how' to explicit understanding. Thus it is most natural to suppose that spoken explanations should be prominent in producing such a change but of course this has not been Piaget's view because it over-simplifies both the nature of the understanding processes and their spoken explanation. Piaget's two recent books (1974a/77, 1974b) point towards a possible answer which should provide an account of the role of speech in conceptualization provided it is seen as part of the ongoing exploratory activity. The ideas are clarified in the concluding chapter of 'The Grasp of Consciousness' (Piaget, 1977): The child's exploratory activity comes first. Only very gradually does he begin to realise what he is doing and to what end, in the sense that he knows what he intends and the means to these ends. However, within this process spoken explanation begins to play an increasingly important part. But even when the child is beginning to reflect upon his directed activities his reflections remain evanescent until they become entirely explicit. But the process of explanation is not the whole of his understanding, nor is it a sufficient cause of development. It only gradually becomes part of the process which enables the child to relate means and ends and to differentiate them from each other. Thus the child extrapolates essential details of his activities, both actions and utterances. These concern specific strategies which are appropriate to the concrete problems he is handling. Applied to the progress children make in seriation this means that they first only distinguish the need to produce the gross configuration but gradually elucidate the whole repertoire of spoken and behavioural strategies which they use to distinguish the essential characteristics of series in general. Finally, at the explicit level, a new synthesis is possible. This is not primarily due to their explanations according to Piaget, but is part of the basic and active elucidating process

which Piaget calls La Prise de Conscience, interpreted (Piaget, 1977) as 'cognizance.

A SYNTHESIS OF THEORY: POLANYI, PIAGET AND AUSTIN

The theories which have been discussed so far now need to be drawn towards a common focus which may throw light on the full implications of the results of this project. It is the ideas of Polanyi (1962) concerning thought and speech which seem to synthesize disparate approaches relevant to this problem. In particular Polanyi's insights can be used to clarify and extend Piaget's (1977) recent reflections. Combined with Austin's (1962) analysis of discourse, these theorists (Polanyi, Piaget and Austin) provide ingredients which together may provide an account of all the present findings combined.

Polanyi (ibid.) was attempting an epistemological study of breadth and depth in his volume entitled 'Personal Knowledge'. His thesis has important implications for the philosophy of science which suggests that ultimately knowledge is not entirely of an explicit nature which can be verified in objective terms. This is because it depends upon negotiations of personal meanings. This thesis can be specifically applied to the present work in regard to: the nature of areas of knowledge which may be either tacit or explicit; the processes of explication; and the role of speech in this process. It may help to clarify and to supplement Piaget's views especially in relation to finding an explanation of the role of speech in dialogue in the development of understanding serial relations in children of 5 and 6 years. Of course Piaget's pragmatic approach is concerned directly with children's cognitive development whereas Polanyi deals with the development of ideas in general by philosophical analysis yet it seems as if these two thinkers may be leading to much the same answer to the question of how the individual resolves the unknown at the threshold of the known and this is the point of the present study.

Polanyi maintains that the domain of tacit understanding is far more extensive than the area which has been or could be made explicit. Some of the tacit areas of knowledge constitute not much more than motor patterns, but much that is understood by man in this tacit sense is quite as complex and skilful as explicit areas of knowledge. Piaget (1974a/77) considers automatic skills such as walking on

all-fours and suggests that such understanding is part of an individual's knowledge without ever needing to be explicit. However, he does not extend his discussion to higher forms of tacit knowledge as does Polanyi. Of these Polanyi provides a striking example when he writes of 'pathetic attempts of microscopy, chemistry, mathematics and electronics to reproduce a single violin of the kind the half-literate Stradivarius turned out as a matter of routine more than 200 years ago' (Polanyi, 1962, p.53). Polanyi is not specific about the origin of knowledge, a large part of which he indicates is not articulated. On the other hand this is Piaget's major theme; to discover this origin as well as to trace the development of explicit reflective forms of understanding. As previously discussed, he attributes it to the directed activities of the individual. Although it is not always clear that he is explicit about what is conceptualized and what is verbalized Piaget (1977) expresses his position in his conclusions:

> All verbalization indeed appears to imply conceptualization and all conceptualization a certain degree of consciousness, but we have not yet taken account of the fact that the reciprocal factors are not true. On the one hand conceptualization is both possible outside language and linked with other forms of semiotic function.... On the other hand, it seems ... that cognizance in relation to the sensorimotor behaviour occurs before the advent of the semiotic function. (Piaget, 1977, pp.328/9).

Thus Piaget describes many types and levels of knowledge both tacit and explicit but the individual's awareness, or cognizance of them is clarified by the child's own interpretation. This interpretive process is elementary at first being in the form of extero- or proprioceptive observation but it may become a more powerful integrative force:

> Nevertheless, it is this interpretation (that is, any form of verbal or imagined conceptualization) that enables the perception to be integrated and that... constitutes its cognizance. Without this interpretation, perception ... remains evanescent. (ibid. pp.329/30).

Piaget and also Polanyi seem to have the idea that man's knowledge or understanding must be conceived as a generic process which evolves into various tacit and explicit forms. It may be entirely automatic but in the process of solving complex problems much of it tends to become organized into relatively stable systems. Knowing becomes 'disciplined' according to Polanyi, it is made conscious or

conceptualized according to Piaget. Verbal manifestations are not necessary in themselves to the disciplining process. There are other possible integrative influences. But Piaget's discussion quoted above indicates that he regards verbalization, or at least interpretive activity, more often than not expressed in talking, as one important integrating influence, particularly because integrated relations will otherwise be unstable and evanescent. He insists (Piaget, 1974a/77) that 'cognizance' is the active process of formulating and of integrating previously disparate features of a problem. In fact he is re-emphasizing points made by him in 1951: There he depicts two levels of intelligence, the sensorimotor and conceptual. The first he likens to a 'slow motion film, representing one static image after another instead of achieving a fusion of images' (Piaget, 1962 pp.238/9). Influences which effect the transition from the first to the second form of thought are: 1) a general acceleration of action patterns which epitomize the whole 'the speeded up film of behaviour thus becoming interior representation, the draft or preliminary schema of the action'; 2) an awareness of this abridged draft which permits reflection in retrospect and prospect; 3) 'the addition of a system of signs to actions' which makes classification and seriation possible; 4) the socialisation that goes with the use of these signs' which integrates individual thought into 'a common reality' (ibid.) Thus even in 1951 Piaget was prepared to suggest that the representation of experience stabilizes the evanescent stream of consciousness. Moreover it also integrates disparate features in a way that enables the individual to reflect upon his experience. 'Cognizance' as he discusses it in 1974a is the tension driven search for resolution of problems which grasps means such as speech in the service of its main preoccupation. Polanyi writing of problem solving in general mentions 'the purposive tension from which no fully awake animal is free'. (Polanyi, 1962 p.120).

The fact that both these writers stress this active innovative drive from known to unknown levels of understanding is particularly apt for interpretation of present findings because it suggests that any means will be automatically intergrated into this focal activity. Piaget seems to make no distinction between the interpretive activity and its medium ('it is this interpretation (that is, any form of verbal or imagined conceptualization) that enables the perception to be integrated' cf. p.145). Probably problem solving occurs most

naturally in a speech mode. The serial problems of the present study were a genuine preoccupation with the children. The means at their disposal were subordinated to this. Polanyi stresses the use of language as a 'transparent' medium of understanding: 'when we use words in speech or writing we are aware of them only in a subsidiary manner' (Polanyi, 1962, p.57). He illustrates this by describing his correspondence which is written in various languages. All he is concerned with is the message conveyed and not the actual words yet when he passes a letter to his son who only knows English he has to check whether the letter is written in this language or not. Piaget (1977) seems to be suggesting that the representation of experience, some of which consists in verbal explanation, may mediate the changing conceptualizations which then become new constructions i.e. they integrate relations at a new level by means of interpretation of experience. Thus speech serves the child's 'cognizance' (growing awareness) by permitting reflection and by crystallizing the ideas which by their nature are most objectively stable e.g. series. Piaget tries to outline how this occurs thus: The child becomes increasingly clear about the end he has in view and gradually distinguishes the means in terms of the definitive relationships of the task, although he only slowly links these relationships into a synthesized unit. This Piaget explains as a centripetal adaptation which starts at the periphery, i.e. the child, the task and the child's actions in relation to it, and moves to the centre, i.e. the child's thinking (interiorized actions and conceptions of the task features). This is a reflective process which becomes increasingly explicit in regard to detailed conceptions of the task and how to perform it. The process gains impetus from external constraints and internal pressures. The child may be inventing notions of his own but he also discovers how they suit the detailed facts of his experience. He explores with purposive intention. He elucidates his conceptions as he tentatively formulates them:

> ... the mechanism of cognizance appears in all these aspects as a process of conceptualization - reconstructing, then going beyond, on the semiotic representational planes, what was acquired on that of the action schemes. (ibid. p.342).

Piaget seems to provide a tight pragmatic account of 'intention' in the conceptualization process which Shotter (1974) described in terms of functional targets. Of course Shotter includes social

communicative processes which contribute to the child's understanding. As previously discussed this aspect lies at the heart of Mead's (1934) thesis and has been resurrected by Bernstein (1973), Bruner (1973, 1975), and Ryan (1974). Its importance is consistently clear in results of the present project. Furthermore, what Polanyi makes of language use indicates its essential place in problem solving if only insofar as he sees the development of scientific thought in terms of controversy (Polanyi, 1962 p.150) and his tendency to let his discussion of descriptive use of speech overflow 'to the interactive and expressive uses of language' (ibid. p.204). He outlines three areas of knowledge: 1) that which is virtually impossible to articulate; 2) that which has a tacit component which can even so be easily expounded since it is already well understood; and 3) an 'area where the tacit and the formal fall apart' (ibid. p.87), the formal being that which can be explained or articulated. This last is particularly apposite in considering how speech affects children's understanding of serial relations just because in this they are 'on the fringe of the known and unknown'. This is an area where the 'speaker does not know, or quite know, what he is talking about' (ibid. p.87). Perhaps he cannot find words to express his ideas because he is relatively inarticulate (the LWC group of study 1 of this project), or his ideas may outrun explanation and force him to innovate new forms of expression. Polanyi elaborates the interaction of speech and cognition thus:

> The domain of sophistication, on which we now enter, is formed by <u>not fully understood</u> symbolic operations which can be:
>
> a) a fumbling, to be <u>corrected</u> later by our tacit understanding.
> b) a pioneering, to be <u>followed up</u> later by our tacit understanding.
>
> More precisely speaking, we should say that we are referring in both these cases to a state of mental uneasiness due to the feeling that our tacit thoughts do not agree with our symbolic operations, so that we have to decide on which of the two we should rely and which we should correct in the light of the other. (ibid. p.93).

Here Polanyi is explaining how speech and problem solving interact, suggesting a mixture of trial and error and innovation in formulating solutions which are 'interpreted' by some kind of tacit evaluation. His account only depicts individual processes but surely in almost all cases controversy and discussion contribute to the development

of new insights. The 'tacit understanding' may arise from other viewpoints. Polanyi refers to adult thought but since it is the development of thought which he is considering this is probably relevant to cognitive growth processes in childhood. Piaget's account of the process of conceptual development is not dissimilar and as with that of Polanyi could easily incorporate social influences within its framework. In both schemes, that of Piaget and Polanyi, the child's ideas and their formulation are being adapted to each other reciprocally. Even if children already seem able to describe relations in some fixed and apparently appropriate format, the use of these in reference will be changed as the child essays a new problem in these terms. One should be warned by Austin's dismissal of pure propositions. If all speech is performatory then there is always some degree of social implication in what is said. In solving problems the child's directed actions and speech are negotiated in terms of the problem itself and the communicative effect of formulating it. Piaget's tendency to minimize the communicative speech function is certainly unrealistic even in terms of his own account of conceptualization. One would prefer to stress it as much as the feedback from experience with objects. Speech elicits 'uptake' (Austin cf. p.139) from others just as the action along with its formulation is adjusted in terms of perceptual interpretation. In dialogue this interpretation must become objective and mutual and this leads naturally to decontextualization of description and of understanding relations in formal general terms. Polanyi's account of this process compels attention because he suggests that this interpretive process is an 'heuristic act'. One may suggest that in the development of formal systems of knowledge spoken controversy consists in heuristic interpretations. Piaget's idea of the development of cognizance is similar. There are increasingly explicit reflections upon actions and their explanations according to him; a clarification of ends and means. This is how Polanyi sees it. He quotes Polya why says of problem solving, 'look at the end. Remember your aim ... Look at the unknown. Look at the conclusion'. Polanyi points out that this means that one should 'look at the known data, but not in themselves, rather as clues to the unknown; as pointers to it and parts of it.' (Polanyi, 1962 pp. 127/8). Although this refers to adult problem solving Piaget's account of how children realise a new representational plane of understanding is

similar. It is just what may be occurring as children synthesize the definitive relations of series. Polanyi insists that discovering a proof in mathematics, for instance, is a purposeful interpretation. (As should be a child's realisation of serial relations). Drawing from Poincaré (1900) he points out that this interpretation is more than learning a sequence of steps, which is no more than learning the rules of chess without applying them. The grasp of a logical sequence is 'something which constitutes the unity of demonstration' (Polanyi 1962 p.110). Similarly for Piaget, the new representational plane of logico-mathematical understanding in children is the gradual evolution of such a unity effected by an explicit interpretive process. Results of the present set of studies suggest that to be most effective this explicit heuristic must be social in children of 5 and 6 years who are realising serial relations. If Austin (1962) is used as touch stone, then to be explicit necessarily has social implications. This would provide the basis for a unified explanation of conceptual development which would satisfy Shotter's ideas about mutually negotiated targets and Piaget and Polanyi's suggestions that heuristic interpretation effects development. They are facets of one and the same process.

Piaget (1974a, 1974b) studied children's grasp of a variety of problems which varied from their understanding of automatic behaviour such as walking on all fours, to their realisation of logico-mathematical relations such as series in the Hanoi Tower game, and seriation of objects varying in different dimensions. Finally he has looked at their grasp of physical cause-effect relations (1974b). Seriation is among logico-mathematical problems which Piaget considers are more likely than other forms of knowledge to be constructed or invented by the child than to be discovered from perceptual evidence. Yet he accedes Sinclair-de-Zwart's point that the differences in a size series are evident and thus easily matched to their descriptions. Thus the descriptions become in themselves operational exercises and the relationships can easily be discovered rather than invented. To this he is willing to attribute the influence of speech on progress though there is little evidence apart from that of Sinclair-de-Zwart (1967). However Peill (1975) considered this issue in relation to conservation of continuous quantity which seems the least likely form of understanding to be discovered and even here children's acquisition was a mixture of both discovery and invention. Although it may be true that linguistic influence will vary according to the nature of the

task and form of understanding being considered, present evidence suggests that seriation is a problem which must be resolved by constructive invention as well as discovery. Certainly perceptual features were not contributive to progress made in results of study 5. If speech is an heuristic, then the suggestion is that new formulations are innovated and then put to the test by social and objective criteria. In Piaget's second study of problem solving and conceptualization (1974b) where physical cause-and effect are considered Piaget admits that whereas speech may have little to do with problem solving at early stages of development there comes a time when there is a mutual interaction of explanation and understanding. This he thinks may occur during the concrete operational stages. Formal operational thinking, which is articulated may indeed govern action directly. The present study endorses, indeed clarifies the evidence that the child who discusses his ideas of serial relations with a guiding adult, formulates them explicitly and that this combination of conditions permits the child to make significantly better progress in his understanding of the relations than in other conditions studied. The child pays little attention to the formal structure of the speech he uses, but his communications become an extension of his heuristic activity. Piaget (1974a) noticed that there was no particular need for the child to be forced to recognize his errors, nor indeed to be involved in contentious controversy. If anything, he made more progress if conditions guided him directly to the correct solution. Similarly present findings also show that the adult's adaptive yet appropriately focussed guidance provided the child with the best means for constructive advance. This of course contradicts Piaget's early (1959) contention that argument with peers assisted cognitive growth (cf. chapter 4 p.68). In terms of Piaget's new view speech becomes a part of the searching and inventive process of assimilation, rather than as imitative accommodation (Piaget 1962). Probably it enters into both aspects of the adaptive process which Piaget envisages. But in the present studies one may venture to suggest that its role is particularly constructive. In these cases the speech can be entirely apposite to the essence of the logical relations being constructed in a series, namely, the 'three element description' which is applied to the 'double comparison' behaviour. Here it becomes an integral feature of the construction. The adult does not impose a formal structure on the child's thinking but allows him to realise for himself

its unity. He is encouraged to formulate his own interpretive integration precisely, appositely and explicitly.

INTERPRETATION OF THE PRESENT FINDINGS

The theorists cited in the last section (Austin, Piaget and Polanyi) were chosen as representing most closely the direction which seems to be indicated for the interpretation of present findings with regard to the role of speech on the development of understanding seriation in children of 5 to 6 years. If one brings these theoretical ideas together they point to the notion that speech used with precise reference to the task or problem which is being resolved is a reflexive interpretive heuristic. It is an integral part of the tension driven search for problem solution. It is also and necessarily a public verifying process, a kind of commitment which entails making subsequent decisions in relation to the point of view of others. Speech cannot be used as a rigid format in this personal and public negotiation but nevertheless it becomes part of a process of formalization because it is public and articulate. As has been seen, none of these writers quite bring all these points together, especially in relating them explicitly to dialogue. This necessary aspect of the process is brought out by those who have indicated the value of G. H. Mead's (1934) ideas, for instance Bruner (1973, 1975), Ryan (1974) and Shotter (1974). This line of approach stresses the importance ofadaptation to 'another's' viewpoint in the process of cognitive development. As previously discussed (cf. pp. 134, 135) there is a growing amount of evidence for the importance of social factors in early speech acquisition (Macnamara, 1972; Greenfield and Smith, 1976, Bruner 1973, 1975). But present results appear to need a synthesis of all the theories cited above in order to interpret how speech operates in the acquisition of seriation. The period when the child realises the significant nature of series in general is particularly interesting because at this point something like the understanding of logical systems is emerging. What do the present findings indicate? From results of study 1 it was clear that speech had a significant part to play in the development of seriation. There were also indications of the kind of influence that it might have: evidently the verbal training had triggered some form of integration of serial relations which were then detached from

particular perceptual instances; the kind of progress made was closely related to the kind of description presently available to the child and this influence was particularly rapid if descriptions were already in the child's repertoire before he began. This close liaison of precisely tuned speech and action was achieved in dialogue. Thus there were intimations of a fairly complete answer in results of study 1: that speech precisely and aptly used in the problem search operated as an heuristic by means of communicative negotiations; a reflective process which produced integration on a representational plane. Subsequent studies endorsed this interpretation: study 2 isolated dialogue as the most effective speech mode; study 3 showed that this was not just a matter arising from contention between peers of equal cognitive status which would force the child to become aware of other viewpoints, rather it seemed to be a directed and adaptive process since dialogue with the observer was the effective influence; study 4 indicated two effective features of the communicative influence of speech, 1) the precise reference to essential relations of the task 2) the child's striving to verify and justify those relations. This implied that the speech form (the comparative terms) used to describe perceptual comparisons was less likely to be an effective factor than the essential meaning or message conveyed in the speech. It was indeed this 'logic' used in another dimension than size (shading) which most influenced size seriation understanding subsequently. Thus in resolving the problem of inserting elements into series, discussion of this problem with an experienced adult who guides and elicits appropriate descriptions is most likely to develop understanding of serial relations. The descriptions need only be appropriate for relations of series in general regardless of the exact speech forms used and the perceptual features they refer to (size or shading). This was endorsed by results of study 5 and confirmed the finding of study 4 that children who were haltingly striving to verify serial relations to the puppet and who managed to innovate some kind of formulation to this end were the best at post-test seriation tasks. Results of studies 4 and 5 indicate strongly that children are wholly preoccupied by the serial problem and those who are in a position to operate at an explicit level use their speech to interpret the whole set of relationships as one. Piaget's slow-motion film of action (cf. p.146) is being translated into the speeded film; rapid reflection can take place and results in synthesis of relations. This is a new

level of operation. But even in 1977 Piaget retains his belief that reversible thinking precedes verbal reflection. In this case this consists in the child's grasp of the double comparison and its description. Results of this study indicate that if the child is given appropriate guidance in describing the exact relations of the problem in the dialogue which permits innovation and negotiation the discussion he has can and does effect the reversible operation. The adaptive 'centripetal process' (cf. p.147) operates faster in these circumstances and thus speech operates as a 'seed crystal' which produces a new synthesis and is not merely a catalyst.

CODA

The results of the present project indicate that conditions which permit speech to serve directly as part of problem solution where the individual may innovate and then negotiate new meanings in terms of the task itself and the viewpoint of others produce progress in the understanding of seriation in children of 5 and 6 years. At the threshold of the unknown the child then uses speech as an heuristic. He neither knows how he is to express himself, nor how new relations are to be united. Adult guidance may elicit the focal units from him but unless he himself formulates and constructs them they do not become part of his own understanding. In order to see this as a combined cognitive reflective process it has been necessary to draw upon the ideas of different theorists and bring them to a new common focus. The view of a language as a formal sign-system is dissipated for it is clearly not useful in this context. Instead the <u>functions</u> of speech have had to be unravelled in terms of how Austin (1962), Polanyi (1962), Bruner (1973, 1975) and Piaget (1977) see conceptual development. The <u>synthesis</u> of their different viewpoints appears to be necessary in order to explain present findings.

APPENDIX I

Photographs of seriation test materials set out overleaf in order as follows:

Loose sets.

Three sets of ten rods of wooden square dowel, each set of a different colour -

Set (a) yellow rods of 1.2 cms square with 2.5 cms size difference;

Set (b) red rods 1.5 cms square of uneven size difference;

Set (c) blue rods .5 cms square with .9 cms size difference.

Covered sets.

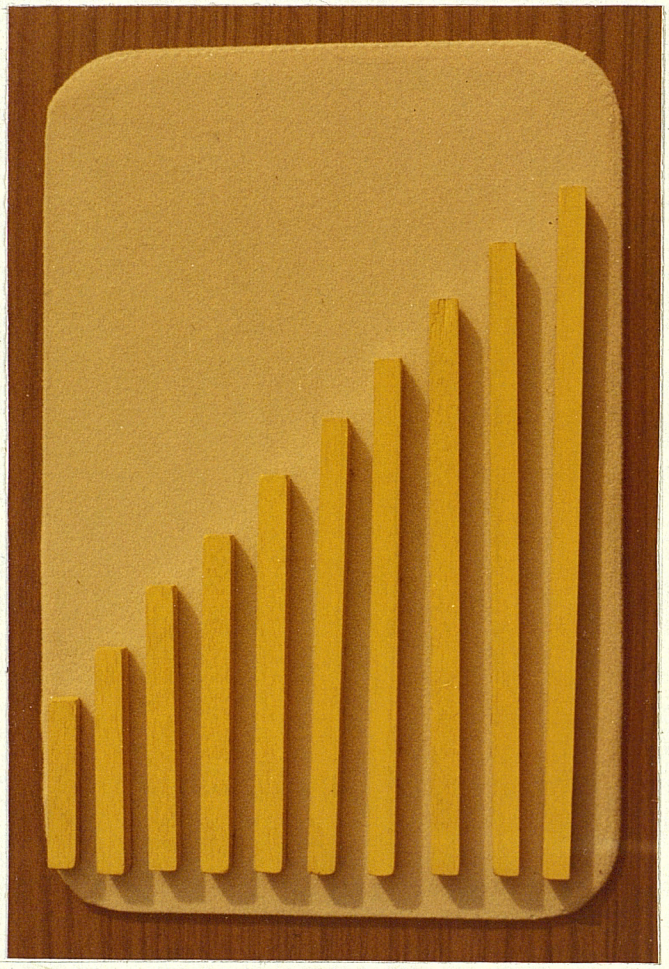
A demonstration set consisting in a grooved board measuring 18 by 26 cms containing a series of five white rods with a red cover with four extra insertion rods, the rods of 1 cm square with a size difference of 2 cms.

For the tasks, three grooved boards each with a covered ordinal series of ten rods placed in the grooves and nine extra insertion rods of contrasting colour:-

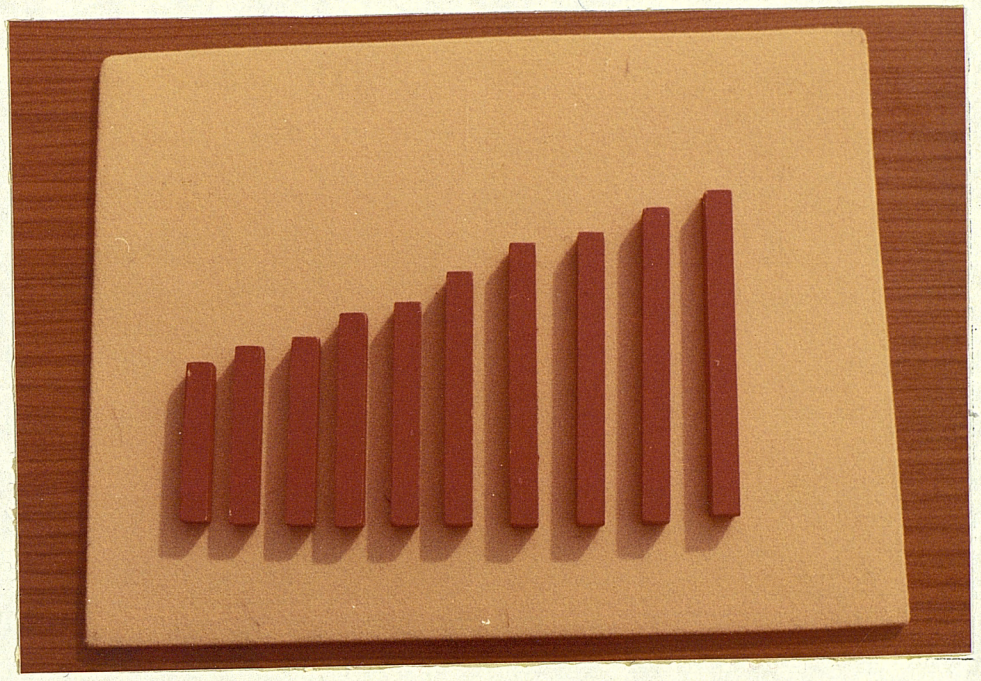
Set (d) a blue series of rods under a yellow cover with yellow insertion rods all 1 cm square with approximately 1 cm size difference, the board measuring 32 by 30 cms;

Set (e) a green series of rods with a mauve cover and white insertion rods all 1.2 cms square with approximately .5 cms size difference, the board measuring 37 by 30 cms;

Set (f) a red series with a blue cover and blue insertion set of rods all .8 cms square with an uneven size difference of approximately .3 cms.



Set (a)



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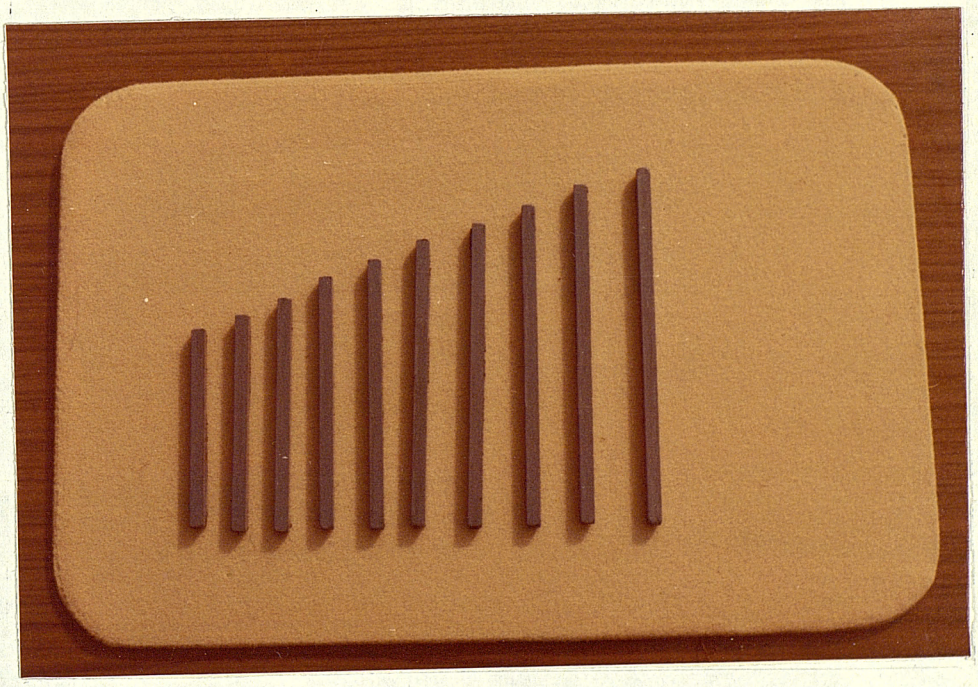
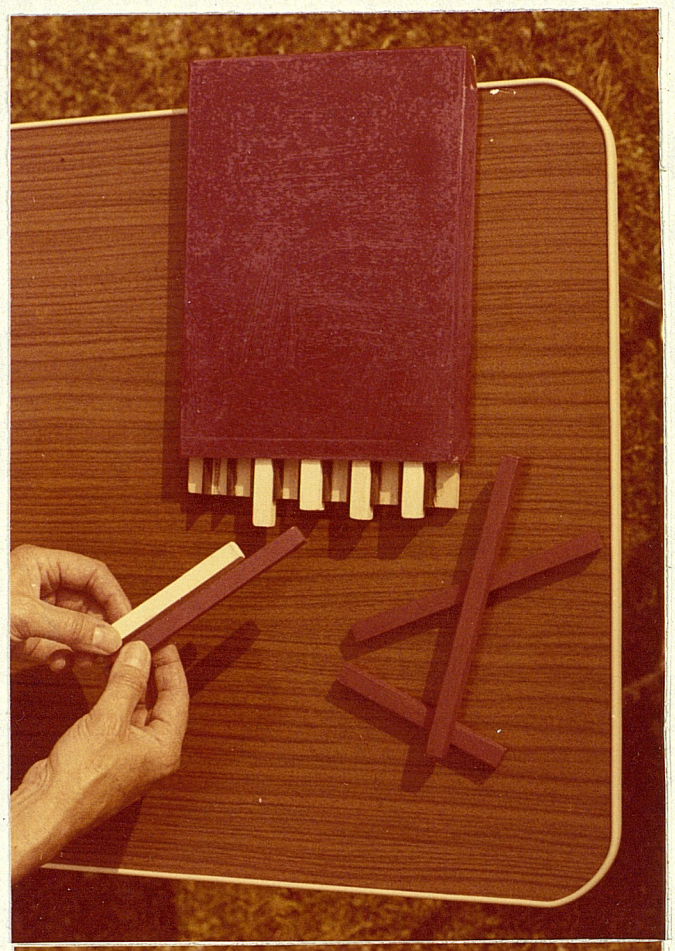
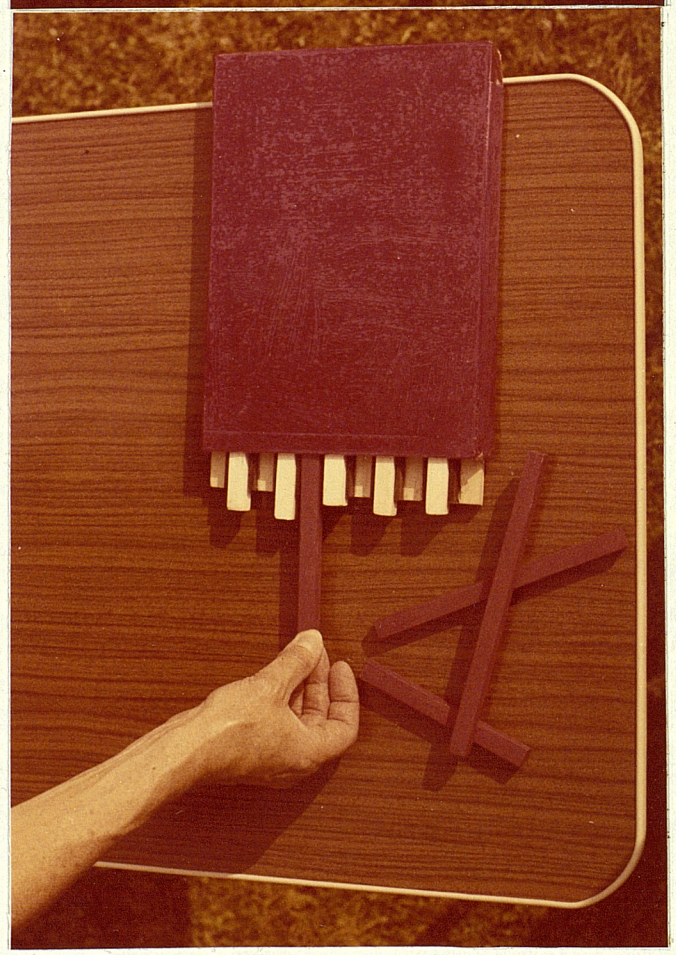
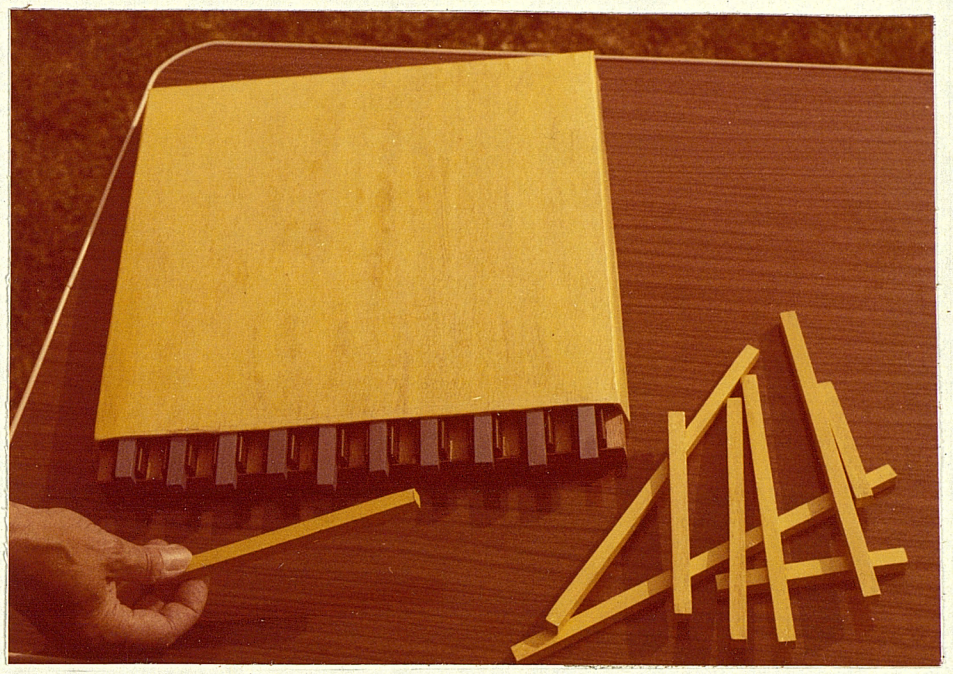


Set (c)

Demonstration set







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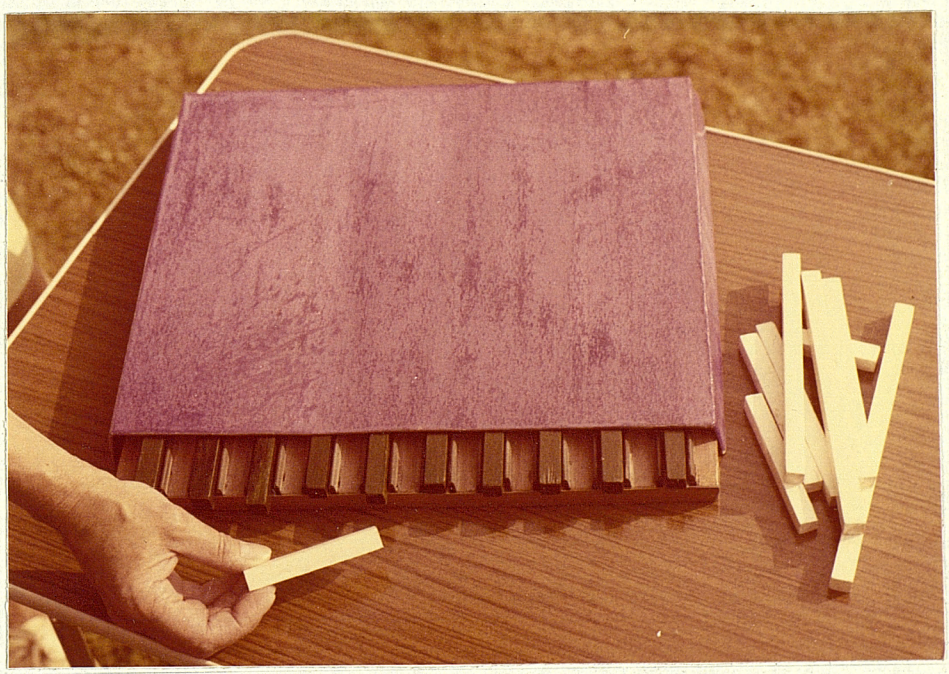

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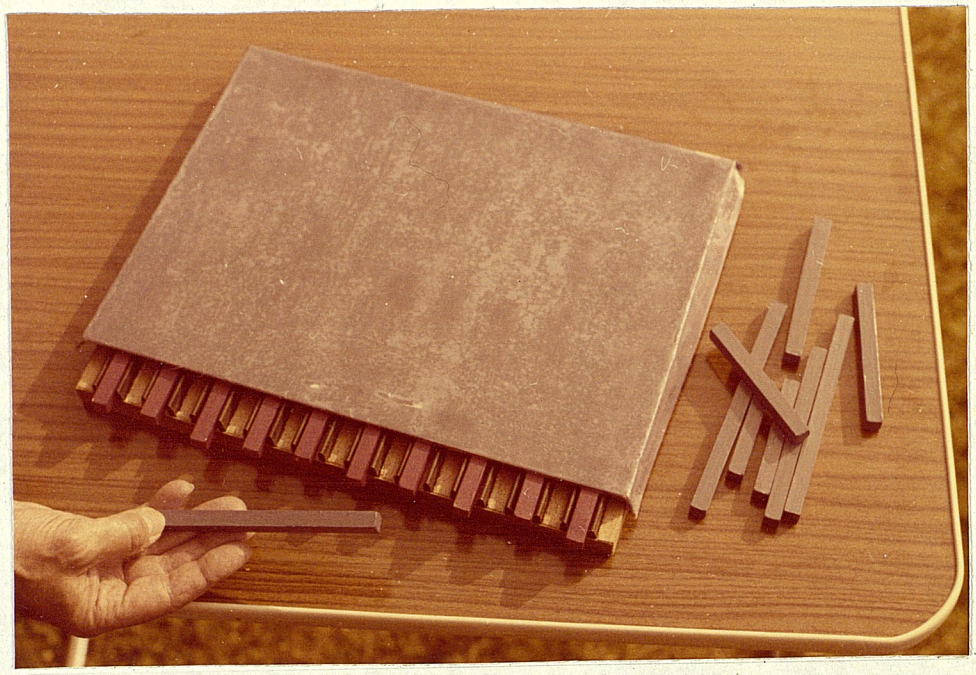

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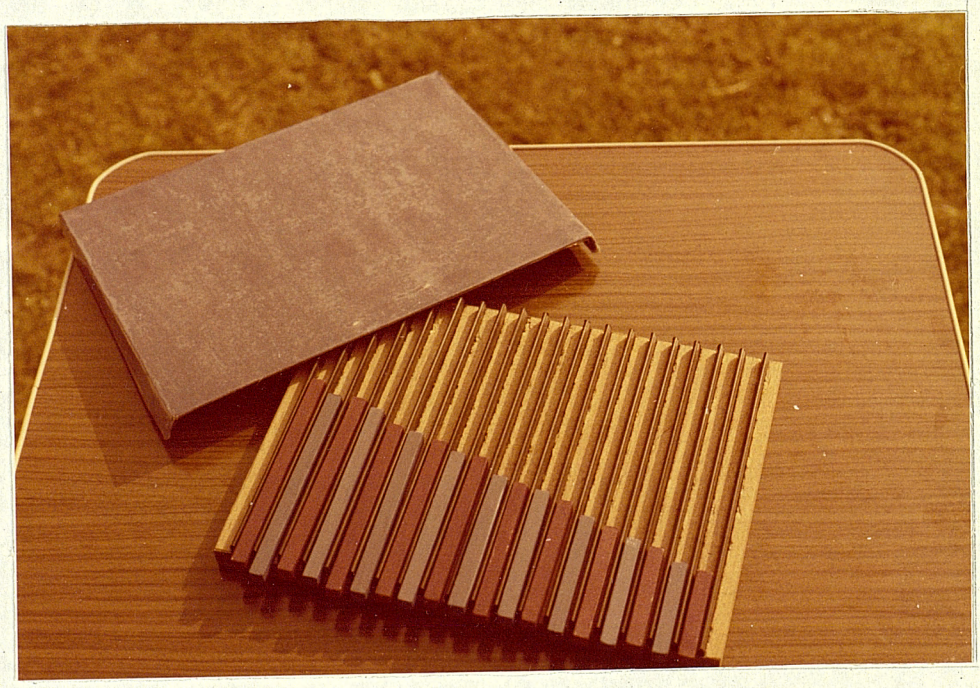


Set (f)

APPENDIX II

Table I Mean scores in 6 tasks - all E's for sessions I, II & III

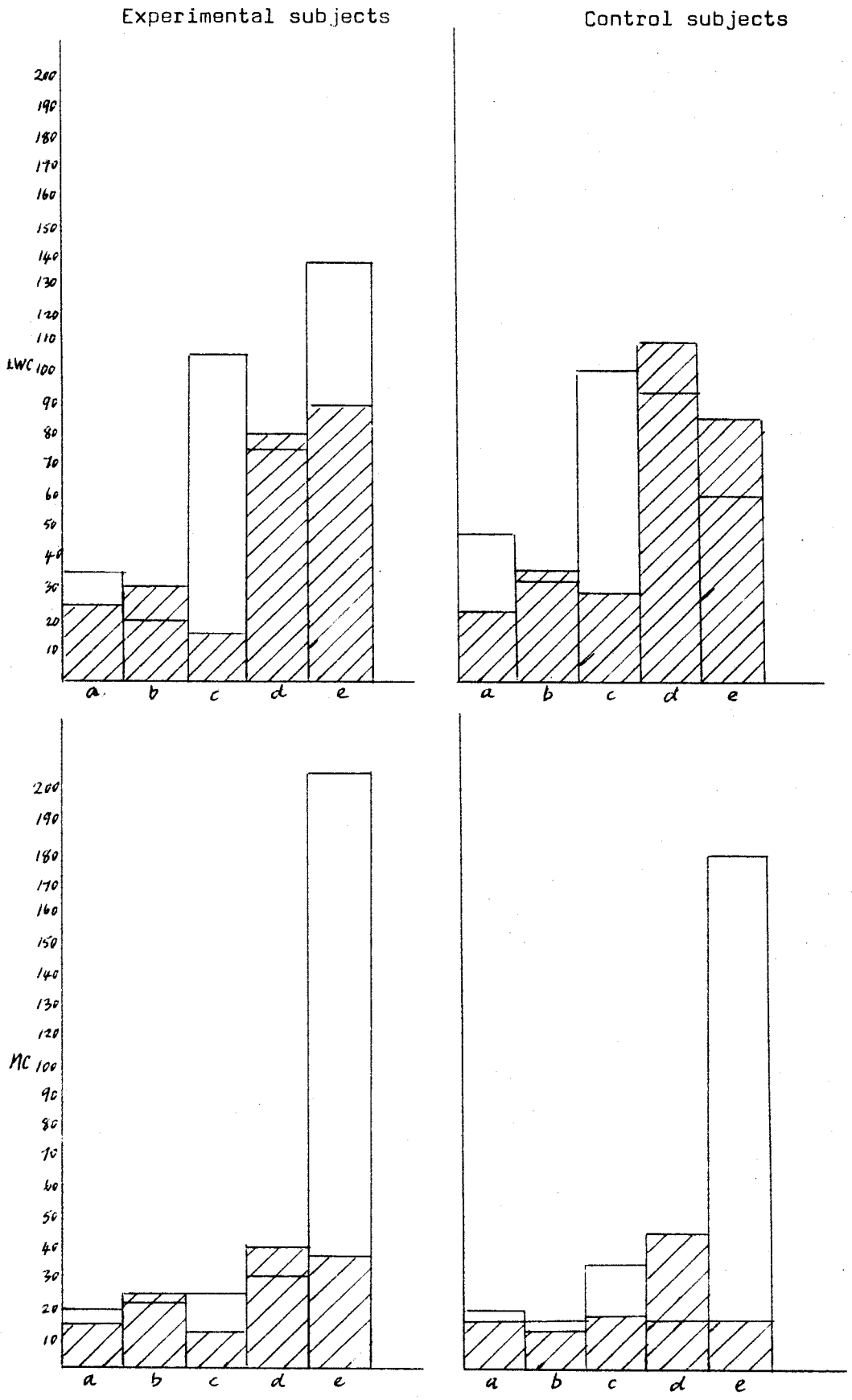
		Tasks					
Sessions	Groups	1	2	3	4	5	6
I	MC	2.4	2.2	2.3	1.6	1.6	1.6
	LWC	2.5	2.3	1.8	1.6	1.6	1.5
II	MC	3.6	3.6	3.7	2.9	2.3	2.7
	LWC	3.1	3.1	3.0	1.9	1.7	1.8
III	MC	4.1	4.1	3.9	2.9	2.6	2.8
	LWC	3.7	3.6	3.5	2.3	2.4	2.4

(stages a b c d e scored 1 2 3 4 5)

Table II Frequencies of scores for stages, a - e in each group. Es & Cs summing tasks 1, 2 & 3 Session I N=60

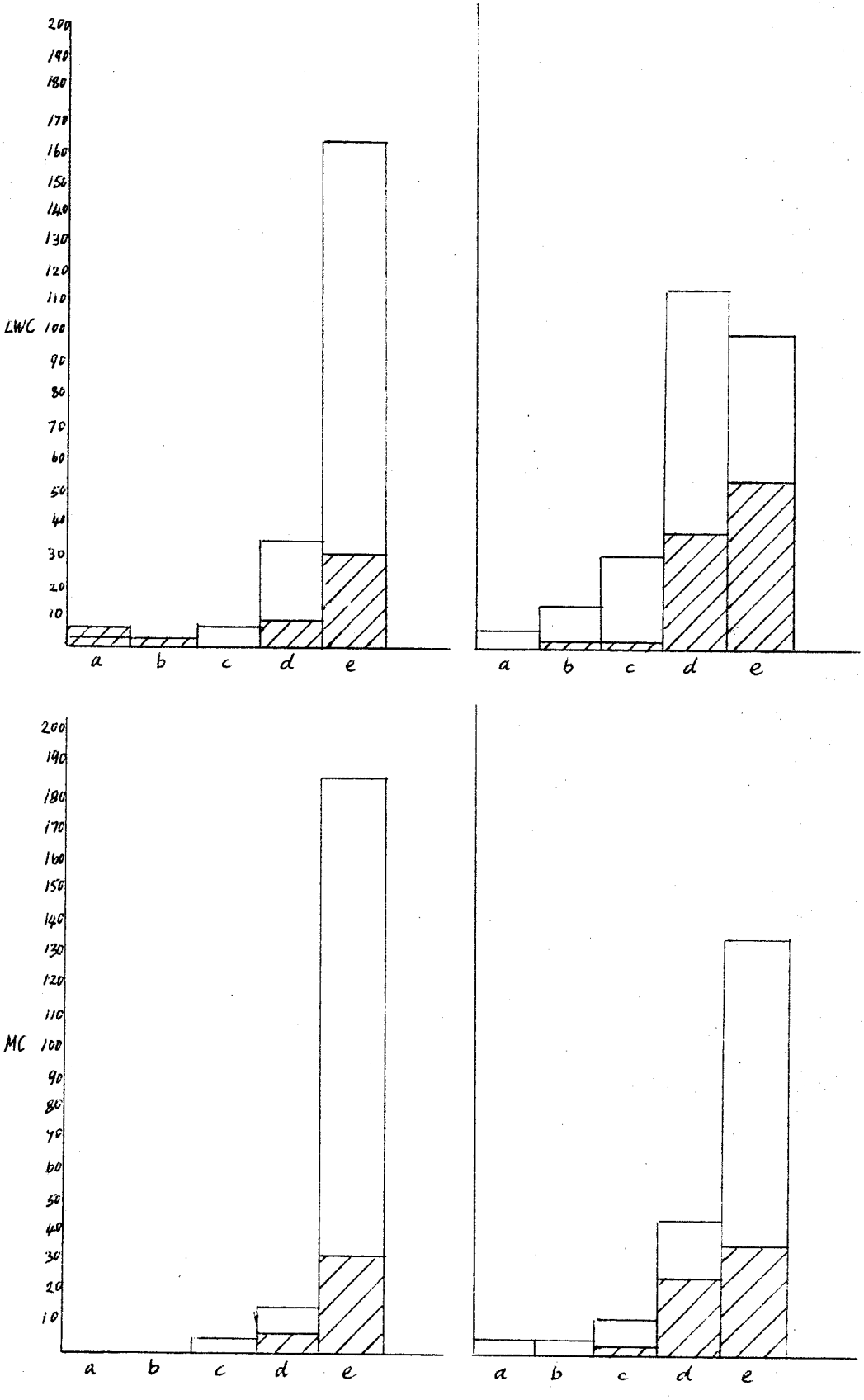
	Stages	a	b	c	d	e
MC	Es	2	19	7	2	0
	Cs	3	7	9	6	5
		8%	43%	27%	13%	8%
LWC	Es	12	5	9	3	1
	Cs	0	16	13	1	0
		20%	35%	35%	7%	2%

Pretest. Description of series - combined number of utterances at each level (a-e) for experimenter ▨ and subjects □ (not the description of three elements),

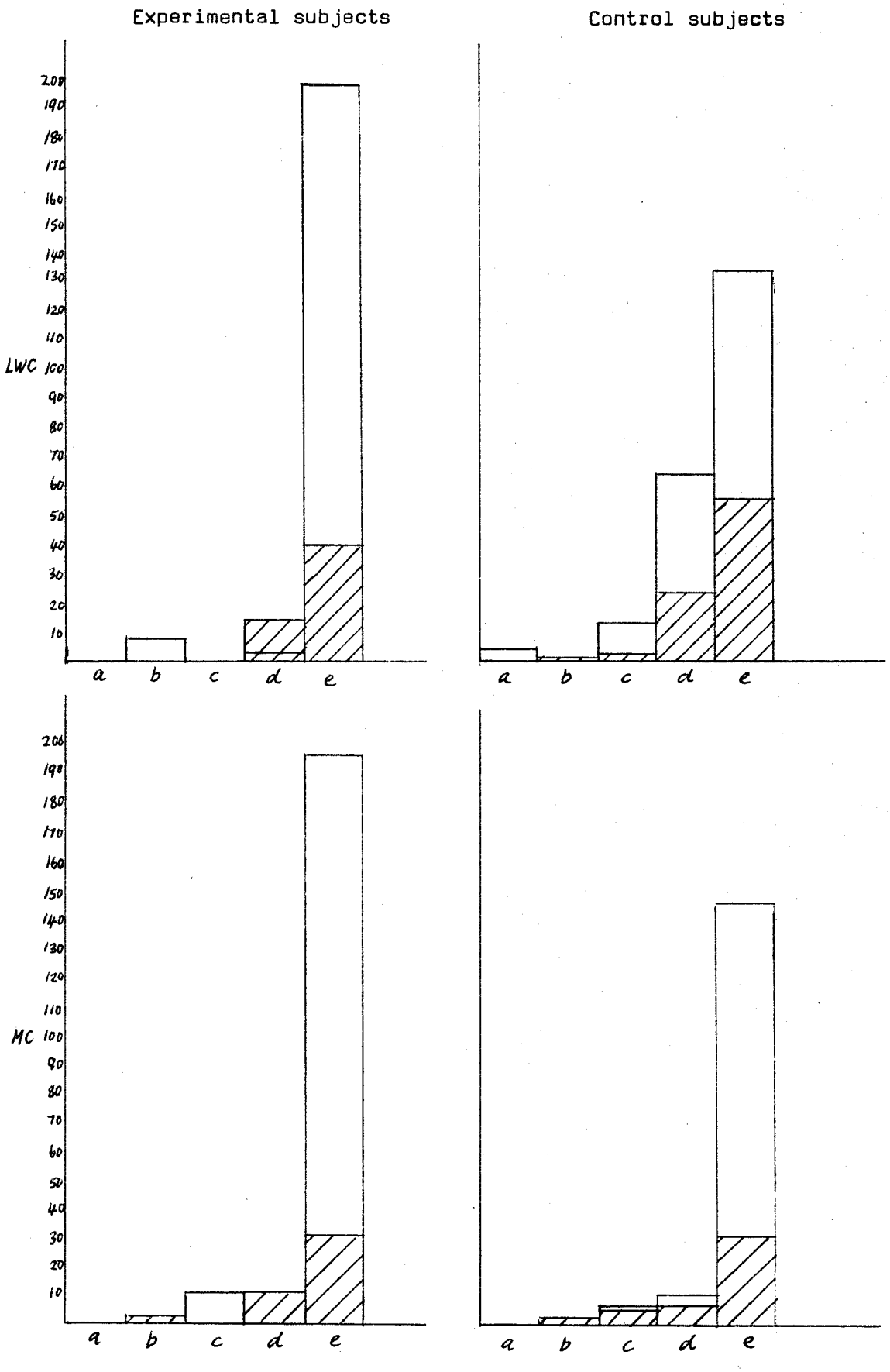


Post-test I. Description of series - combined number of utterances at each level (a-e) for experimenter ▨ and subjects □
(not the description of three elements.)

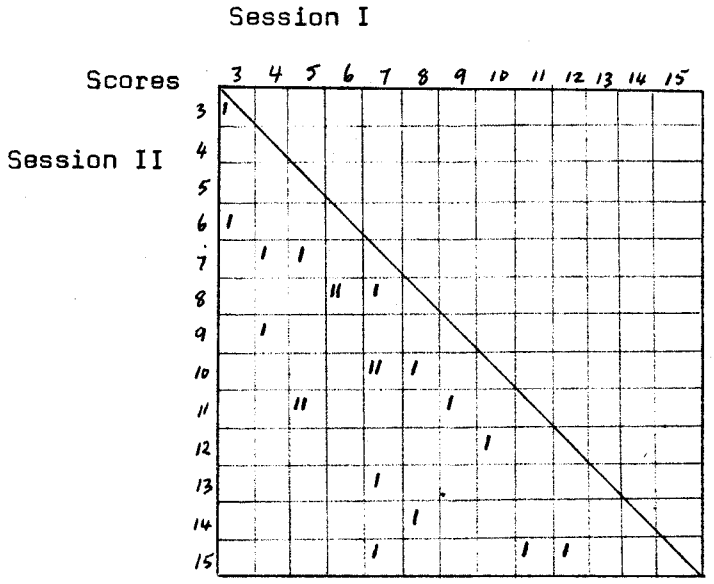
Experimental subjects | Control subjects



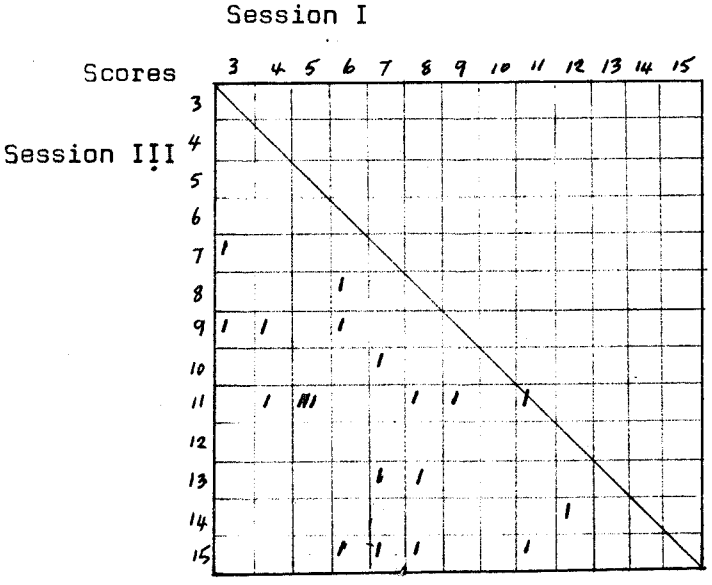
Post-test II. Description of series - combined number of utterances at each level (a-e) for experimenter ▨ and ▭ subjects (not the description of three elements.)



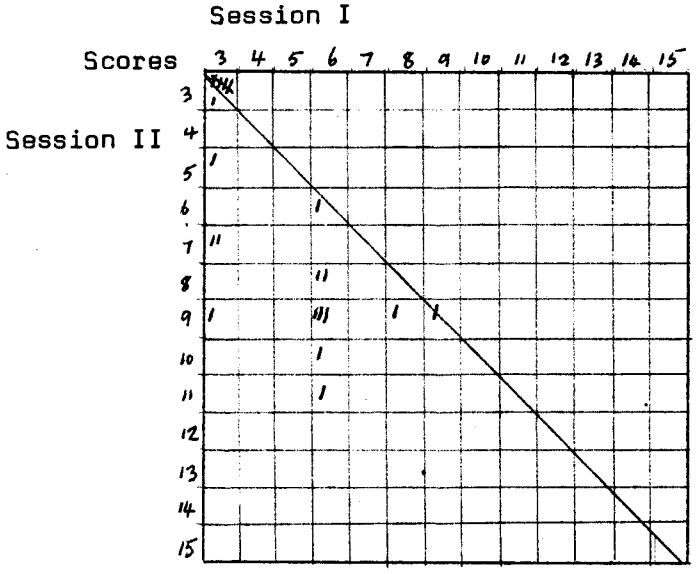
Matrix of scores at sessions I & II all Es tests 1,2 & 3 combined.



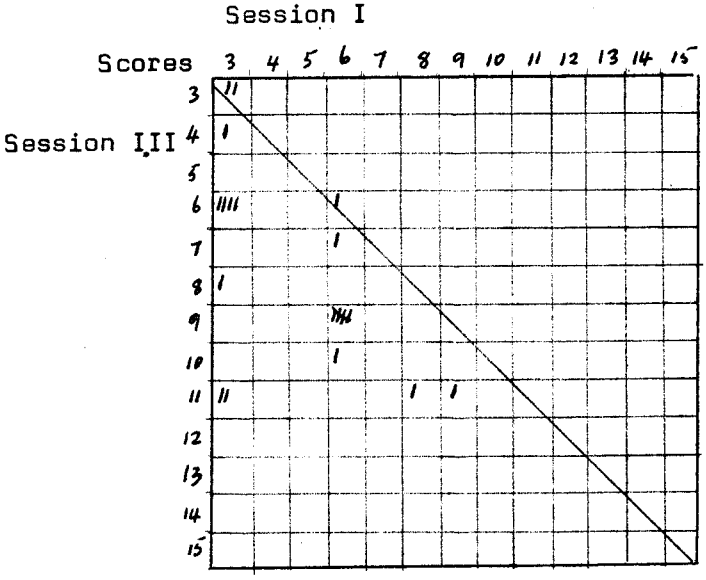
Matrix of scores at sessions I & III all Es tests 1,2 & 3 combined.



Matrix of scores at sessions I & II all Es tests 4,5 & 6 combined.



Matrix of scores at sessions I & III all Es tests 4,5 & 6 combined.



APPENDIX III

Examples of transcriptions of video taped recordings of seriation covered-set tasks: pre- and post-tests of one child for one task from each respectively.

Notes:

Observer typed in lower case, child in upper case

i = insertion rod; rods in covered-set numbered 1 to 10; C = comparison made with i; rods in covered-set oriented either from left to right or vice versa, 1 to 10 or 10 to 1 indicated by description 'to left' or 'to right', where 1 is the smallest and 10 is the longest rod. The original transcriptwas treble-spaced to allow for annotation.

Pre-test:

Girl; task 1

Speech	Action
Alright Sarah, that's the rod to find the right place for and you'r allowed to take any sticks out	i LEFT ON BOARD, C1 TO RIGHT, HELD OVER i AND RETURNED, C10 TO LEFT, PLACED TO RIGHT OF i ON BOARD (i much shorter), C9,C8,C7,C6 (close in size) PAUSE, RETURNS 6 INSERTS i TO LEFT OF 6, LOOKS UP AT O
right, now what makes you think that's the right place? THIS ONES JUST A LITTLE BIT TALLER THAN THAT ONE Do you need to look at any more? Have you looked at enough have you? YES shall we have a look? See if it's right	POINTS TO 6 THEN i LOOKING AT O SLIGHT NOD
Is it quite right? NO You were almost there Good good lovely	removes lid (i too short) LOOKING MOVES i BETWEEN 5 AND 6

Post-test I

task 2

MUCH TOO BIG yes	C10 FROM LEFT, PLACES TO RIGHT OF i, REPLACING 10, NODDING FIRMLY
	C8 PLACED TO RIGHT OF i, SLIGHTLY LONGER THAN i (close) PICKS THEM UP TOGETHER GAZING AT GROOVES, AND
WHOOPS	INSERTS TOGETHER WITH i TO LEFT OF 8
	i DROPS OUT ONTO FLOOR PICKS IT UP, C8 PLACED TO RIGHT OF i AGAIN, REPLACES 8 FIRST, THEN INSERTS i TO LEFT OF IT, SUDDENLY REMOVES i
	C4 HELD TO RIGHT OF i (i much longer), C8 HELD QUICKLY TO LEFT OF i, REPLACED, C6, QUICKLY PLACED TO
Don't hurry about it. Go steady	LEFT OF i (i longer) C7 PLACED TO

task 2 contd

	LEFT OF i A BIT SHORTER THAN i
IT GOES THERE (murmuring)	PAUSES LOOKING AT THEM, C6 TO LEFT OF
YES THAT ONE SHOULD GO THERE	i, INSERTS i BETWEEN 6 AND 7
Now have you looked at enough? YES	
Why does it go in there? THAT ONES TALLER THAN THAT ONE AND THAT ONES SMALLER THAN THAT ONE	POINTS FIRST FROM 7 TO i THEN FROM 6

Post-test II

task 3

OH NO	EXTRACTS AND REPLACES C10 FROM RIGHT
SMALL, OH IT'S GOING OFF	THE SAME WITH 1 IT SLIPS
UM	C4 PLACED TO RIGHT OF i (i a little longer)(close) C3 PLACED TO RIGHT OF i (longer), C5 TO RIGHT OF i (very slightly longer than i) IMMEDIATELY INSERTS i BETWEEN 4 AND 5 QUICKLY TRIES 4 AGAIN THEN 3 EACH PLACED TO LEFT OF
THINK IT'S THAT ONE	i AND BOTH ARE SHORTER THAN i, C4 AGAIN PLACED TO RIGHT INSERTS i BETWEEN 3
are you sure? NO I'II JUST TRY THIS ONE	AND 4, REMOVES C4 PLACED TO RIGHT OF i (4 slightly shorter than i) PAUSE HOLDS ON TO i WITH LEFT HAND WHILE RETURNING 4 LEAVES GO, HAND TO MOUTH SEEMS DOUBT-FUL C3 PLACED TO LEFT OF i, C4 PLACED TO RIGHT OF i (both are shorter than i)
HAVE I LOOKED AT THAT ONE? yes NO OH IT'S ---- I'M NOT SURE IF THAT'S BEST TALLER	TRYING 3 AGAIN REPLACES IT, C5 PLACED TO RIGHT OF i IT IS VERY SLIGHTLY LONGER THAN i, PAUSES C6 PLACED TO RIGHT AND JUST LONGER
TALLER SMALLER SMALLER	C5 AGAIN, C4,C3 BEGINS TO INSERT i BETWEEN 3 AND 4 BUT STOPS
LET'S SEE AGAIN SMALLER SMALLER OH I CAN'T ---	C4 PLACED TO RIGHT OF i C3 HESITATES OVER C4,C5, SPACE, C7 TO RIGHT
TALLER SMALLER TALLER very close isn't it?	OF i, C5 PLACED TO RIGHT OF i, PAUSE, C4, C6 TO RIGHT C5, SCRUTINISES
SMALLER, I THINK I'II JUST LOOK AT THIS ONE ONCE MORE AND THEN I'II CHOOSE, TALLER um THERE NOW IT IS	LOOKS UP AT 0
there why is it there? COS THAT ONE'S (pause) TALLER THAN THAT ONE AND SMALLER THAN THAT ONE	C6 TO RIGHT INSERTS i BETWEEN C4 AND C5
GOT ALL OF THEM RIGHT	TAPS 6, PAUSES DRAW OUT 10
	TAPS 5 AND i removes lid (correct)

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