

A COMPARATIVE STUDY OF THE COGNITIVE DEVELOPMENT
OF THE INFANT WITH DOWN'S SYNDROME AND THE
NORMAL INFANT

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I hereby declare that this thesis is my own work,
and has been completed within the normal terms of
reference and of supervision in the Faculty of
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ABSTRACT

This thesis investigates the cognitive development of the mentally handicapped infant in comparison with that of the normal infant. It has been claimed that the course of cognitive development in the infant with Down's Syndrome ('mongolism') can be explained as a 'slowed down' version of the development exhibited by the normal infant (as described by Piaget and others). In this thesis criticism is made of this 'slow development' theory. It is argued that such a formulation can, at best, offer a description of certain differences in developmental outcome (namely the delayed emergence of critical achievements on the part of the Down's Syndrome infant). It cannot explain why such differences occur.

The necessity for analysis to proceed beyond a level of 'first emergence' is demonstrated by the findings of a comparative longitudinal study of cognitive development in the Down's Syndrome and the normal infant. It is shown that the nature of both success and failure on tasks relating to cognitive development is different between the two populations. It is argued that such differences must be seen as more fundamental than delays in outcome, and that an adequate explanatory model must therefore concern itself with the former.

A theoretical account is presented which focuses attention on the manner in which competence is acquired, rather than on the formal properties of such competence. It is argued that for the Down's Syndrome infant, in contrast to the normal infant, acquisition and change cannot be posited to take place with respect to high levels of organisation of response. On the basis of this account, a prediction is derived concerning the efficacy of techniques designed to enhance

the performance of the Down's Syndrome infant. Evidence is presented to show that enhancement can occur if appropriate restructuring of task presentation is made. It is also demonstrated that such enhancement is not exhibited by formally matched younger normal infants, under the same conditions. This finding confirms the view that the cognitive development of the Down's Syndrome infant must be seen as different from the normal, rather than merely 'slower'.

General implications for both the normal and the handicapped infant are discussed. With respect to the latter, particular attention is paid to the role of deliberate intervention in early development.

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BIBLIOGRAPHY

CHAPTER I : INTRODUCTION

1. Cognitive Development and the Down's Syndrome Infant

1.1 Introduction

A large corpus of psychological experimentation with human infants has taken its inspiration from the work of Piaget, first reported in the 1930s (published in English as Piaget 1953, 1955). This work concerns itself with the infant's perception and understanding of his physical world, and of his active engagement with it in the form of adaptive behaviour. Central assumptions of this approach are that behaviour must be seen as organised (and thus individual elements of behaviour can be neither random nor totally independent); that large scale changes in organisation take place with time; that such changes cannot be adequately explained in terms of changes in elements; and that such changes are, in general, progressive, and tend to increase the infant's degree of adaptation. The term 'cognitive development' is used to refer to the substance of such an approach to infancy.

Generally, the cognitive-developmental approach seeks to account for the behaviour of infants in naturalistic situations, in which some form of intelligent activity is called into play. The investigation of behaviour in more artificial contexts is a means to this end. It is the general features of the organisation of action, within the natural setting, which are of interest, and especially the transformations which are observed in the forms of organisation. The ethological nature of the approach demands that all forms of organisation must be seen as possessing some degree of

adaptation to the salient environment. Development is not, therefore, seen merely as an accretion of the skills or habits characteristic of the mature individual. Emphasis is placed on the structural integrity of behaviour at all points in the life-span. These features set the cognitive-developmental approach apart from, for example, accounts of development derived from learning theory which characteristically focus on single elements of behaviour.

Research into cognitive development has concentrated almost exclusively on the normal infant. With respect to handicapped infants, the earliest comparative work might be said to be that of Décarie (1969), with infants phocomelic as a result of the drug Thalidomide. This population was studied chiefly in order to assess the universality of certain Piagetian predictions, rather than as a contribution to an understanding of the development of the handicapped infant as such. It will be argued below (1.5) that research derived from the cognitive-developmental framework might in fact make such a contribution. It will be argued that the general end of understanding the nature of mental handicap in infancy should be brought closer by research in this general framework. Before a description of this framework is given, some characteristics of the specific population under study will be presented.

1.2 Down's Syndrome

Down's Syndrome (henceforward DS), formerly known as 'mongolism', is the largest single condition contributing to the incidence of mental handicap (Clarke & Clarke 1974). The condition is

identifiable at birth, chiefly by means of the physical stigmata (Smith & Berg 1976). DS is characterised by the increased dosage of specific chromosomal material. In over 95% of cases, the increased dosage consists of a whole extra chromosome 21 in each somatic cell. Less frequently, a fraction only of this chromosomal material is additional. Birth incidence is stable across cultures and geographical areas, at some 1.5 per 1,000 live births (Smith & Berg 1976).

It is unusual for gross physical handicaps to co-occur with DS, but a range of minor handicaps are often associated. The most commonly associated secondary handicap is congenital heart defect (CHD) which is largely responsible for the relatively high mortality rate in the first year. In addition, however, there are frequently upper respiratory and immunological difficulties, and occasionally auditory or visual handicaps.

The extent to which DS may be taken to represent mental handicap in general is not clear. Anecdotal evidence for the uniqueness of the DS population (with respect to behaviour) has not been substantiated (Belmont 1971). In this thesis, DS will in general be discussed as a distinct population. However, much of the relevant literature has not considered DS separately from other conditions. It will therefore be necessary to make certain assumptions concerning the equivalence of different populations in drawing inferences from such work.

1.3 The Piagetian Approach

The Piagetian tradition presents probably the most cohesive system

available for the conceptualisation of behavioural development in infancy. Piaget's original approach can best be seen in contrast to classic procedures for assessing children's mental development. For Piaget, a child's 'incorrect' reply to an adult's question must be seen not as an end of investigation (when transformed, for example, into a cross on an IQ form) but rather as a beginning for further study. For Piaget, the child must have had a rational reason for the nature of his answer. It could not be seen merely as a random, 'trial and error' response. This conviction led Piaget to question the child further about his initial response. Thus a semi-structured 'interview' came to be adopted as the chief means of investigation.

Piaget's subsequent work with (his own) infants (1953, 1955) was prompted by a desire to trace the prelinguistic genesis of certain aspects of intelligent behaviour. The method used was strictly analogous to that employed with children. Instead of verbal questions, physical problems were presented to the infant in a semi-structured 'clinical' manner and the infants' responses observed at different ages. The 'probing' aspect of this approach, in response to the subject's behaviour, and the rejection of the simple 'pass or fail' as a source of information all set Piaget's approach apart from the contemporary approaches to the psychological evaluation of the infant (e.g. Gesell & Amatruda 1947).

One school of research has remained very close to the 'clinical' aspects of Piaget's methodology. This 'Genevan' school has retained the theoretical approach and the methodology of Piaget's own work, although various extensions and adaptations have

been made. The Anglo-American tradition of experimental psychology has also shown great interest in the phenomena described by Piaget. However, they have been studied with a different methodology. Further, Piaget's own theoretical account has been seen as only one way of interpreting the observations which he presents. Thus this second tradition has taken an 'operational' approach to the Piagetian findings. The observations and the theory, once presented as an integrated whole (Piaget 1953, 1955) have been separated out (see Gratch 1975). It has been argued that both advantages and disadvantages have resulted from this procedure (Broughton 1970).

It should be stressed that both schools give an equal emphasis to the centrality of the phenomena Piaget described. Both consider it vital to obtain a complete understanding of the development of mental abilities in the infant. Both stress that such an understanding must transcend a mere comparison with the adult mind. Both insist that it is the more general aspects of intelligent behaviour which are of the greatest importance, rather than isolated performance. It is these common features which will generally be referred to as the 'Piagetian approach'.

1.4 Piaget's Account of Cognitive Development in Infancy

Piaget's original account is presented in the form of two parallel descriptions. First Piaget (1953) presents an account of the infant's progressive construction of that 'practical' (non-verbal) intelligence which he demonstrates by the age of two years. Piaget discerns six distinct stages of development, each

characterised by a qualitatively different form of intelligent action. The attainments of each of the six stages (Stages I - VI) are described in terms of the increasing plasticity with which different systems linking perception and action are co-ordinated. These systems, or schemata, can finally be co-ordinated 'mentally', without overt action being necessary. Such 'mental manipulation' defines the end point of this whole ('sensorimotor') period of development. This achievement enables the child to start using language as an alternative to action. Thus this whole period may be considered equivalent to that commonly referred to as 'infancy' : the time before speech.

In his second volume, Piaget (1955) describes the same six stages with respect to specific domains of development, rather than the global forms of intelligence. Each section presents a set of observations of the developing infant's differential response to the same or similar problem situations. The first section contains perhaps the most striking observations, and perhaps it is partly for this reason that it is the section given most attention by Anglo-American psychologists. In this section, Piaget describes the responses of infants to the movement and concealment of desired toys.

For Piaget, the two year old's understanding of objects is perhaps his greatest achievement. It is certainly the prototype of cognitive structure at the culmination of infancy. For Piaget, the two year old has achieved an understanding of the physical world which ascribes 'permanence' to perceived objects. Thus the child has created a universe populated by solid objects whose existence is independent both of himself and of his actions. Such objects

continue to exist even when concealed by another object, or when sharing the motion of a second occluding object. This achievement is described as the possession of the mature 'Object Concept'.

All these features are, for Piaget, great achievements in comparison to the newborn's conception of the physical universe. Piaget presents an analysis of the gradual construction of the 'Object Concept'. Each of the six stages of sensorimotor intelligence is shown to be associated with a different stage in this construction.

A brief summary of the characteristic features of the six stages, according to Piaget's (1955) analysis, will now be given. Illustrative references to observations in Piaget (1955) are given in brackets. The description of tasks designed to test for these features is given below (Chapter III : 3.2).

- Stages I & II : No special response to objects going out of sight
- Stage III : Retrieval of an object when partially hidden by an occluder, but not when completely hidden (0.23)
- Stage IV : Retrieval of an object completely hidden by an occluder. However, on the object's subsequent concealment by a second occluder (in a different location), search at the first location only (0.40)
- Stage V : Immediate retrieval of object from a series of different occluders. However, when the transportation of the object to the occluder - and its release there - is performed with the object concealed in a container, the infant will search in the container only. Finding it empty, he will cease searching (0.55)

Stage VI : In the above procedure, inspection of the container is immediately followed by retrieval of the object from the occluder (0.64)

Piaget emphasises the importance of the achievement indicated by such behaviour. The responses diagnostic of 'Stage VI' of the development of the Object Concept are seen to imply the mental manipulation of the representations of objects. Thus a global change in the infant's understanding of the universe has taken place:

"... during the sixth stage, the co-ordination of the schemata is internalized in the form of mental combinations ... Thereafter deduction of the object and of its spatial characteristics is achieved in the construction of a collective universe in which displacements that are merely indicated are inserted among observed movements and complete them in a truly coherent whole". (1955, p.96)

The culmination of infant development - as manifested in the ability to deduce the location of an object after non-visible displacement - can therefore be seen as the foundation for subsequent achievement:

"Thus may be seen the unity of the behaviour patterns of the sixth stage: mental combination of schemata with possibility of deduction surpassing actual experimentation, invention, representative evocation by image symbols, so many characteristics marking the completion of sensori-motor intelligence and making it henceforth capable of entering the framework of language to be transformed ... into reflective intelligence". (1953, p.356)

For Piaget, then, the changes which are observed in the infant's response to displaced objects can be taken as an index of cognitive

development as a whole. The level of understanding of the physical world which is demonstrated by the infant, in solving the problems with displaced objects, represents the highest achievement of infant intelligence. At the same time, it represents the beginning of the 'reflective' intelligence characteristic of the child and adult: the most striking manifestation of which is the use of language.

1.5 The Importance of Comparative Research into Cognitive Development in the Down's Syndrome Infant

The area of research with which this thesis is concerned is of importance for a number of reasons. In addition to the significance for the study of mental handicap, both in infancy and beyond, the comparative perspective offers a contribution to more general issues of development.

With respect to the mentally handicapped infant, it is important to assess the contribution of the Piagetian approach. This system would seem, at present, to constitute the most complete and cohesive account of infant development available. Moreover, it presents a model of development in which attention is focused on cognitive and intellectual factors - in contrast, for example, to the emphasis of Gesell on motor attainments. In principle, such a model should be uniquely appropriate to the psychological investigation of mental handicap in the infant. It is important to determine to what extent this is the case.

At the least, it seems likely that the richness and detail of the Piagetian approach will illuminate the development pattern of

the DS infant. With the present emphasis on early intervention with the DS infant (e.g. Brinkworth 1973; Hayden & Haring 1975), a more complete understanding of their development is becoming urgent. If 'stimulation' programmes are to be effective, they must be designed and carried out in the context of such knowledge. The setting of goals for intervention - as well as the rationale for the practice itself - must be related to a detailed knowledge of the processes of development in the handicapped infant.

In order for the investigation of the handicapped infant to generate information relevant to these issues, it must be carried out in a comparative framework. If it is carried out in isolation from the study of normal development, there is a danger that inadequate models of development may be adopted and, thereby, unproductive questions posed. The comparative paradigm makes it possible to keep in perspective both similarities to, as well as the differences from, normal development. Such an approach also has more general advantages. The study of development under the influence of a handicap gives an important perspective on normal development. It offers the possibility of separating out the characteristics of 'normal' - i.e. non-handicapped - development from those common to all populations (and thereby characteristic of 'development' per se). Thus it will be possible to account for 'normalcy' in development in ways which go beyond the cataloguing of 'norms'.

The specific chromosomal anomaly in Down's Syndrome makes its study of significance to the problem of genotypic influence on development. It is important to establish how direct a relation holds between specific chromosomal dosages and behavioural outcomes. It

must, of course, be borne in mind that for Down's Syndrome the extra dosage is (generally) a whole extra chromosome per somatic cell. It is important to determine whether differences in developmental outcome may be described and accounted for in simple terms. If so, some direct causal link may be posited between the chromosomal anomaly and the course of development. If, however, the differences from normal development are found to be complex, then such a simple relationship could not hold. The genetic anomaly will still be seen as the original cause of the problem, but developmental outcome will be seen as mediated by numerous interactive processes. In such a case, the role of environmental manipulation is undetermined. More generally, such a conclusion would suggest that genotype is only one of a number of factors contributing to developmental outcome. Even where major differences from the normal karyotype occur, a course of development cannot be seen simply as the necessary 'expression' of the genotype.

This section has discussed some general issues, some of which will be taken up again following the presentation of the present research. Next, however, the more specific concerns of this thesis will be introduced.

2. Previous Research and the Theory of 'Slow Development'*

2.1 Introduction

Little information is yet available on the cognitive development of the DS infant. However, a section of the literature is of indirect relevance to this issue. Indeed implications drawn from it

* see Appendix

have, so far, substituted for specific investigation. This work consists first of other work with DS infants, and second of work with mentally handicapped children as a general population. As will be shown, these two sources of information have converged on a broad 'theory' of the cognitive development of the DS infant. Since this theory will subsequently be criticised, it is necessary to summarise the work and the conclusions which have been drawn from it. Following the criticism, certain other work will be reviewed which lies outside the two sources noted above, and which, it will be argued, supports a different approach to the problem.

2.2 Research in the Psychometric Tradition

Psychometric studies of the DS infant evolved from the experience of clinical assessment. Practices such as general screening, the prediction of future attainment and the recommendation of care or placement relied on the use of psychometric 'baby tests' (e.g. Gesell & Amatruda 1947). It was assumed that determining the characteristic pattern of results on these tests would facilitate these practices and, further, would give rise to a clear understanding of the development of the DS infant.

The psychometric account makes use of descriptive terms which are of a highly derived nature, in comparison with the original data. Such data consists of binary (pass or fail) scores on a set of items. By comparison with scores obtained by a normative sample, the sum of correct scores is transformed into an equivalent-age score (the Mental Age, or MA). Dividing the MA by the subject's Chronological Age (CA) yields a ratio score. When initial testing is carried out

with an Intelligence Test, this ratio score is termed the Intelligence Quotient (IQ). In the case of infancy, where broader 'developmental' tests are administered, the ratio score - obtained in an identical manner - is termed the Developmental Quotient (DQ).

Studies in the psychometric tradition have evaluated DS infants on 'developmental' tests such as those of Gesell (Gesell & Amatruda 1947) and Bayley (1969). Infants have been tested in a longitudinal fashion in studies such as those of Dameron (1963), Carr (1970) and Dicks-Mireaux (1972). The graph of MA results with increasing CA has been found to have a positive slope, with a gradient less than 1. That is to say, despite absolute increases in raw score with CA, there is an increasing divergence from scores determined to be norms for specific CA. Where testing has been carried out with respect to different areas of development (e.g. 'mental' and 'motor' development as defined by Bayley's (1969) Scale), similar results have been found in each area.

The construct of DQ, in terms of which these findings have frequently been expressed, has been explicitly associated with childhood IQ (e.g. Dameron 1963). However, DQ has been found to be a poor predictor of childhood IQ (see Honzik 1976). Despite its analogous method of computation, then, (with respect to the raw data), the construct of DQ cannot be assigned validity on the basis of an association with the IQ. Its value must be evaluated within the context of infancy itself.

As noted above, level of achievement - that is, measured Mental Age - falls further behind Chronological Age expectation as infancy

progresses. Thus the ratio of the two (DQ) exhibits a negative slope with respect to time. This pattern has been interpreted as a 'progressive deterioration' (Dicks-Mireaux 1972). Thus the negative slope exhibited by the DS infants is being compared unfavourably with the constant value exhibited by the normal infant. This latter pattern is, however, determined by the nature of the DQ; the normal infant must, by definition, have a constant DQ since he supplies the norms to which achievement is compared. Constancy of DQ cannot, therefore, be seen as a constructive achievement of the normal infant. As a corollary, it would not seem legitimate to interpret a decline in calculated DQ as a substantial 'deterioration'. Certainly such a conclusion would not seem to offer any advance in terms of explanation. The decline in DQ must be seen as a reflection of the abnormality in development, rather than its substantial cause.

It is not only with the derived measure of DQ that the psychometric approach becomes unsatisfactory. The more fundamental concept of Mental Age leads to the same problems. As noted by Melyn & White (1973), when

"(use is made of) mental age as a standard for evaluating other aspects of development ... Differences between retarded and non-retarded children are ... seen as quantitative and not qualitative. Indeed, the mental age concept cannot accommodate qualitative differences between individuals, whether retarded or not". (p.421)

The psychometric approach assumes that all differences are 'quantitative' (i.e. that they can be expressed by mapping between MAs). It will be argued below that, on the contrary, it is

'qualitative' differences which generally characterise the mentally handicapped infant.

However, it should be emphasised that the psychometric approach has been sensitive enough to demonstrate certain differences among the DS population. For example, higher levels of performance (at equivalent CA) have been shown for the home-reared as against the institutionalised infant (Centerwall & Centerwall 1960; Stedman & Eichorn 1964) and for infants enrolled in intervention programmes at the pre-school level (Ludlow & Allen 1979). Such findings clearly suggest a degree of plasticity in the development of the DS infant with which the most radical forms of the psychometric approach would appear to be incompatible (e.g. Dicks-Mireaux 1972).

The comparison of different sections of the DS population, by means of the psychometric approach, can therefore clearly provide useful information. With respect to the DS population as a whole, however, the approach might seem to be capable of little beyond a demonstration of global inferiority of performance on the part of the DS infant.

To summarise, the psychometric approach has shown that the DS infant can be expected to achieve the 'milestones' of development later than his normal peers. Since the norms of such achievement are placed on a time-scale, this pattern may be described as 'slowness'. Attempts have been made to explain this pattern in terms of constructs such as Mental Age and Developmental Quotient. It has been argued above that such explanations have not in fact clarified the phenomena.

2.3 Research in the Piagetian Tradition

The earliest, and still the most influential study of the mentally handicapped to be carried out within the Piagetian approach is that of Inhelder (1968; first published 1943). In this study a large number of subjects, aged from 7 years to adult, were assessed on tasks relating to 'concrete operations' (in the terms of Piaget's system). These tasks concern such features as the conservation of quantity, which are acquired by the normal child during late childhood (Piaget 1974, p.58).

Inhelder (1968) found that the performance of the retarded subjects could, in general, be equated with that of younger, normal subjects. Inhelder suggested that the 'level' of development revealed by her analysis might be seen as the 'end-point' or 'ceiling' of the individual subject's development. Thus the subject was 'fixated' at a certain lower level of development.

Inhelder found that 'fixation' could occur at various levels of development, including the 'intuitive' or 'pre-operational' level characteristic of the normal young child (of 2 - 7 years). The level of 'fixation' was found to be correlated with the degree of handicap (as assessed by more traditional methods). In terms of the then current system of classification, Inhelder claims that:

"the imbecile is capable of intuitive thought ...
the retardate is capable of operatory construction
which he is incapable of completing". (Inhelder 1968, p.293).

Within the same formulation, it is claimed that:

"the idiot never outgrows the sensori-motor
compositions". (ibid., p.293).

It should be noted that no evidence for this latter claim is presented by Inhelder.

In view of the ability range of Inhelder's sample, it is likely that subjects with DS were included (although no confirmation of this is given). It is not possible to make any specific inferences concerning the DS population - and certainly not DS infants - from Inhelder's results. It is the more general findings which have been of influence. Of greatest significance are the implications for the course of development in the individual which are drawn from the cross-sectional data. Inhelder has stated that:

"The developmental sequence of stages (in the retarded child) is ... the same as that of normal children". (Inhelder 1966, p.311).

In the absence of work with younger subjects, or longitudinal study, this conclusion might best be seen as tentative. The theoretical problems associated with such assertions will be discussed below (2.4). It should be noted at this point that the conclusions of Inhelder have been of considerable influence, and have been taken to be of general application to cognitive development in the mentally handicapped (e.g. Odum-Brooks & Arnold 1976).

Inhelder's claim for equivalence between the mentally handicapped and the younger, normal child rests on the analysis of performance in terms of 'levels' of development. In general, subjects exhibited 'homogeneous fixation' at a level below that appropriate for chronological age, and

"(there was) no room for doubt as to the structural identity of the intellectual reactions between the retardate and ... young normal children".
(Inhelder 1968, p.285).

However, certain subjects could not be characterised in terms of 'homogeneous fixation' at a certain level. In keeping with Inhelder's intention to extend analysis

"far beyond assigning the retardate to a given level of development" (ibid., p.325)

these subjects are given considerable attention.

These subjects are described as exhibiting 'disequilibrium'. 'Disequilibrium' is manifested by 'oscillation' (in a single session) between 'the ordinary levels of development'. Two forms of 'disequilibrium' are of interest here. One is characterised by 'progressive oscillation' in which the subject appears to make real progress during the session. This is explained by suggesting that some factor had been holding the subject back from achieving his 'true' level (and that the interview enabled this to be overcome).

The second form is the 'true oscillation'. Here the subject appears highly sensitive to suggestion by the experimenter, or other transient environmental influences. Any apparent progress made by such a subject must be deemed superficial. It should be emphasised that this pattern, like the 'progressive oscillation', was characteristic of only a fraction of Inhelder's sample and was not seen as of general importance. Thus the occurrence of 'oscillations' has not been given much attention by later researchers. It has not been seen to affect the nature of Inhelder's major claims. The

picture has emerged of the mentally handicapped child being equivalent, in terms of cognitive development, to the younger normal child.

Subsequent research has concentrated on the assignment of individuals to stages or levels of development. A number of studies will be briefly reviewed. In general, as will be noted, the trend has been away from classical Piagetian analyses and towards the operational approach embodied in such sets of scales as those of Uzgiris & Hunt (1975).

Woodward (1959), in a cross-sectional design, assessed two groups of children and adolescents on both general sensori-motor intelligence (problem-solving) and object permanence. Of the first group, 14% were DS (aged between 7 - 16 years), and of the second group, 35% were DS (age range 7 months - 15 years). Results are presented in terms of Piaget's sensori-motor stages and show an even spread across these stages. Thus most of the children were performing at levels functionally equivalent to the normal infant. The quoted correlation (87%) between the two measures is not analysed for the contribution of CA. Evidence for the sequential nature of the items is derived from the ranking of items by relative number of subjects passing. The obtained order for the set of items therefore represents an overall order of difficulty at the time of assessment. Such an order need not be identical to the order in which achievements first emerged. The conclusion that

"severely subnormal children pass through these steps in the same sequence as ... normal children up to the age of two years" (Woodward & Stern 1963, p.10)

would not therefore seem to be justified.

Rogers (1977) has clarified some of these points. In a study which investigated a wider range of Piagetian 'categories', to include Causality, Space and Imitation, a similar sample was investigated. The maximum proportion DS (not precisely stated) was 10% (aged 8 - 15 years). Again a spread of functional levels (in terms of sensori-motor stages) was observed. Ordinality of responses in the different domains was found to be high, but the predicted correspondence between domains was low. Correlation between CA and functional level was non-significant.

All the above studies have been concerned with the mentally handicapped as a general population. Even where the exact proportion of DS subjects is stated, differential analysis is not given. This procedure makes it difficult to draw inferences concerning the DS population as such. One study which has concentrated on DS subjects alone has been that reported in Moore & Meltzoff (1978). As part of an investigation into the relationships between cognitive development and language, eleven young DS children (aged from 3:8 to 5:3 years) were given a single assessment on a set of 'object permanence' tasks. The authors report that an identical order of difficulty was obtained for the DS children as for normal infants (but with delayed emergence on the part of the DS infants).

This finding supports those reported above, and suggests that it will not generally be inaccurate to assume that results obtained for mentally handicapped children in general may be posited for the DS population in particular. However, with its cross-sectional design (further limited by the small age range) it does not avoid

the problems noted above. It is not necessarily the case that order of difficulty for a set of items, at a certain age, is identical to ontogenetic order of acquisition. Even if this identity does in fact hold, the practice of extrapolating from cross-sectional data might prevent more subtle differences from being revealed by longitudinal investigation.

One study has used the longitudinal design with respect to performance on 'object permanence' tasks. Wohlheuter & Sindberg (1975) followed the progress of 67 children (aged one to six years old), a sample which included an unspecified number of DS subjects. In general, the median ages of emergence of specific achievements followed the order expected for the normal infant. However, ranges were extremely large and it is not clear whether statistical analysis would have revealed a significant correlation with chronological age. Further, it is noted that a number of subjects manifested highly variable performance across sessions (in addition to a number who made no progress, and thus remained on a 'plateau'). 'Reversals' - that is, failure to repeat a prior achievement - were noted for a number of subjects, including some who demonstrated a generally constructive pattern. No figures are available to quantify this feature, and the implications of such findings are not discussed in depth.

This study clearly indicates that the limitations of cross-sectional studies (as presented above) are serious ones. When subjects are investigated on a longitudinal design, deviations from the normal pattern begin to appear. The support these findings offer to the more detailed results of Inhelder (1968), as noted above,

should be emphasised. They have not been seen as a challenge to the view that, in general, cognitive development in the mentally handicapped child can be seen as 'slow'.

Experimental investigation has then clearly demonstrated that the performance of DS children on tasks assessing cognitive development falls far below that of their normal peers. This finding has been most clearly demonstrated in the domain of 'object permanence'. Order of difficulty for sets of tasks is broadly equivalent to the normal case, and age of first emergence of criterial achievement can be expected to parallel normal development, at least to a first approximation. These findings have given support to the view that, in a strong sense, the pattern of development is identical in the DS and the normal population. Many studies have not investigated performance in sufficient detail to enable a precise evaluation of this proposition. The most detailed investigations have revealed, or suggested, areas of difference between the two populations. These differences have not, however, been seen as sufficient to weaken the claim for fundamental identity between the developmental patterns. The description of the cognitive development of the DS infant as being 'slow' is generally accepted.

There is clearly a convergence between the conclusion of the literature derived from Piaget's studies, and that of the psychometric tradition presented above (p.12). The DS infant is seen as manifesting 'slow development'. Such a theory is taken to explain the larger part of experimental findings and clinical observation. In the two following sections, criticism of this theory

will be made; first on theoretical grounds, and second on empirical grounds.

2.4 The Theory of 'Slow Development'

(i) Theoretical Considerations

The concept of 'slow development' has emerged from two distinct research traditions. The two theoretical systems concerned, the psychometric and the Piagetian, express the concept in different terms. Both versions, it will be argued, can be criticised on theoretical grounds. The major criticism, which can apply to both versions of the theory, is concerned with the problem of circularity. Since this problem arises most clearly with respect to the psychometric version of the theory, this will be discussed first.

The psychometric approach to development draws an analogy between psychological change and physical growth (see Bower 1977a). By this analogy 'slow' development would correspond with slow physical growth. The validity of this analogy might be seen to receive support from the finding that physical growth (height and weight) is retarded in the DS infant (Cronk 1978). In this context, where growth can be plotted against time in a quantitative fashion (in terms of cm. or kg.) the term 'slow' can be used in a precise manner. Growth is, here, a mathematical function of a metric quantity with respect to time. Derivatives of the primary function (such as rate or acceleration) can also be given a precise meaning. The validity of these usages depends on the fact that the dependent variable can be observed and measured independently of the independent variable.

In drawing an analogy between psychological development and physical growth, it is important to note that, whatever the validity of the analogy, the level of description is not transcended. If it is accepted that 'mental growth' can be measured accurately, and independently of chronological age - by means of tests - it would still only be possible to obtain a precise description of observed changes. 'Slow mental growth' is identified by measuring instances of retardation in performance. It cannot, by itself, be taken to explain the occurrence of such instances. In this respect, 'slow growth' or 'development' can be taken only as a description, and not as an explanation. To use it as an explanation would be to fall into circularity.

In its strongest form, the psychometric approach does not appeal to any outside factor to explain measured changes. In this form, then, it cannot be seen as offering an explanatory theory for the phenomena of mental handicap in development. However, certain approaches similar to the 'strong' psychometric approach have recognised the necessity for positing the influence of other factors on development. What must be considered is the extent to which these approaches constitute an advance over the 'strong' psychometric argument. If they can provide a means of anchoring 'mental growth' within some independent framework, then such a modified version of 'slow development' might be more satisfactory.

The introduction of biological maturation into a theory of slow development has been made by Lenneberg (Lenneberg et al. 1964). Lenneberg's empirical work is concerned with language use, and will not be discussed in detail. However, it is important to consider the role

which 'slow development' plays in this approach. For Lenneberg, development can be broken down into different 'facets'. Slow development occurs with respect to each 'facet', but to different degrees. Thus a major change to the strong psychometric argument has been made. The concept of unitary growth, which might be indexed by a single measure, has been replaced by the more complex picture of a set of domains with some degree of independence.

For Lenneberg, the different facets of development can be seen as lying on a single dimension, with respect to the extent of biological determination. Thus physical and motor development are opposed to domains of development in which cultural factors are seen to have a significant influence. Lenneberg argues that, in the case of DS, development will be affected to a greater extent in those domains less under the control of biological factors. In this category he includes areas responsible for intelligence-test performance.

This separation out of different domains of development, with the associated prediction of differential retardation, might make it appear that the problems of circularity with the psychometric approach have been avoided. Explanation for developmental outcome is not being given in terms of change in a unitary underlying variable. However, unless it is possible to establish, independently, the relative contributions of biological and cultural factors to outcome in the various domains, the same problems will emerge. Explanations for outcome will still appeal to outcome itself. For example, the location of language-use on the dimension of determination is, essentially, determined by the results of empirical research with DS

children. This location - on the 'biological' end of the dimension - cannot, without circularity, be used to explain the same empirical findings.

Lenneberg's analysis presents a general theory of development, within which the case of DS plays a certain part. In contrast to such a general viewpoint, mental handicap itself may be seen as the central issue. Explanation will then take the form of a 'theory' of mental handicap. The approach of Zigler (1969, 1973) constitutes a 'slow development theory' of mental handicap. For Zigler, differences in intelligence-test performance between the handicapped and the normal populations can be expressed in terms of 'developmental delay' on the part of the former.

'Developmental level' (however measured) is taken as an adequate explanation for such differences. It has been argued here that, on the contrary, 'slowness' or 'delay' in development can only be a description of outcome. As noted by Ellis (1969), in a criticism of Zigler's theory,

"The statement that (children with differing IQ) are at 'different developmental levels' does not provide an explanation". (Ellis 1969, p.563).

Before concluding the discussion of those versions of the theory of 'slow development' broadly derived from psychometric tradition, some attention should be given to certain related approaches. If the concept of 'slow development' as such gives rise to problems, it might be possible to translate it into terms which enable empirical testing to be carried out. Perhaps the most satisfactory such procedure would concern itself with neurological correlates of behaviour. If

developmental change in general could be explained by reference to characteristics of the central nervous system, then 'slow development' might be accounted for within the same theoretical system. The necessarily complete neuro-behavioural model is not however available. In its absence the concept of slow growth in neural tissue (see Brinkworth 1973) cannot be considered sufficiently precise to serve as an explanatory underpinning of 'slow development'.

It has been suggested (e.g. Benda 1969) that the influence of neurological deficits should be sought in the process of neural transmission taken to underlie learning. Thus performance in learning situations might be used as an index of underlying neurological deficit, and might thereby provide evidence independent of the assessment of 'developmental level'. However, the most rigorous work yet available shows that the learning of a choice-discrimination is equally fast in the normal and the retarded subject, once the appropriate dimension of difference has been identified by the subject (Zeaman & House 1963). Attempts to legitimise the term 'slow development' by an appeal to neurological processes would appear to be, at best, premature. The fundamental problems of the psychometric version of 'slow development' are not obviated by the theoretical developments which these attempts represent.

When the Piagetian version of the theory is considered, it is apparent that many of the above criticisms could also apply to it. To the extent that the Piagetian account of development can be reduced to a set of achievements at certain ages, it clearly resembles the 'milestone' approach of psychometrics. This problem arises, for example, with the scales derived by Uzgiris & Hunt (1975). Here,

sequences of criterial achievement in six areas of cognitive development are presented. The instrument is intended to be used for assessing cognitive status in infants in the context of research, e.g. for the purposes of comparing the effects of different caretaking environments (Paraskevopoulos & Hunt 1971). It is not intended as an absolute measure of level of cognitive development (Uzgiris, pers. comm. 1977). However, it is being seen as an operationalised form of the Piagetian theory, and as essentially equivalent to it (e.g. Cicchetti & Sroufe 1976). It was pointed out above that Piaget's major impetus for investigating the cognitive structure of children was his conviction that mere passes and fails on a test gave very little information about the child. It is perhaps unfortunate that an instrument using precisely this method is now being seen as encapsulating the Piagetian approach.

It is from the structural aspects of the Piagetian tradition that the way of avoiding the problems of the 'milestone' approach must come. Piaget's (1953, 1955) accounts describe not only criterial successes or achievements but also errors characteristic of specific stages. The concept of 'stage' fundamentally insists that successes or errors (as judged by the adult) result from the operation of identical processes in the child. Thus there are coherent laws describing behaviour in a wide range of situations at any one time. The categorisation of the child's behaviour into 'passes' or 'fails' is a secondary procedure.

If the Piagetian account is reduced to a set of criterial achievements, then, it is vulnerable in the same fashion as is the psychometric version of the theory. If, that is, the 'stages' are

reduced to 'sequences', what has been produced is a more refined psychometric instrument, rather than one appropriate to cognitive development. Instead it is necessary to consider behaviour in problem situations in greater detail. Piaget makes very clear statements of the characteristic errors associated with the stages of sensorimotor development. These have been clearly summarised (and further interpreted) by Bower (1974a, pp.181-5). Thus, for the strongest version of the Piagetian theory of slow development to be correct, characteristic errors should be found in the mentally handicapped infant associated with his current status in terms of achievement. Since such evidence is largely independent of the primary data - of slow achievement - its demonstration would give substantial support to the theory.

It may be concluded that to the extent that 'slow development' is expressed solely in terms of age-related achievement it has little explanatory power. However, an 'enrichment' of the theory is possible within the Piagetian framework, by means of which the theory might be made more productive. In general, little progress can be made while account is only given of 'quantitative' differences, that is to say those differences which take the form of delays. For theoretical purposes, it is necessary to incorporate other kinds of difference, which may be termed 'qualitative differences'. The following section will present the argument that, in terms of empirical evidence, such 'qualitative' differences must be considered fundamental.

2.5 The Theory of 'Slow Development'

(ii) Empirical Considerations

Many attempts have been made to discern qualitative differences between the mentally handicapped and the normal population. Here a brief summary of some general results will be given. Following this, research specifically with Down's Syndrome in childhood will be considered in greater detail.

Classic accounts of mental handicap postulated such qualitative differences as the slow conductivity of neural tissue (e.g. Benda 1969). Specific anatomical differences in brain tissue have been found (see Crome & Stern 1972). For example, the reduced weight of the cerebellum in DS has been related to such behavioural features as deficient fine motor control (Frith & Frith 1974).

More recent work has considered the differences in the course of learning in the mentally handicapped. As previously noted, Zeaman & House (1963) found that performance on a two-choice discrimination problem could be described in terms of two components: the subject's identification of the correct dimension of difference of stimuli, and the subsequent learning of the appropriate discrimination on that dimension. It was only on the first of these components that the performance of the mentally handicapped was inferior to their peers.

Other work concerned with learning has expressed its results in more general terms. Qualitative differences have been described in terms such as a deficiency of spontaneous learning (Denny 1964) and the need for deliberate structuring of the learning task by the experimenter or caretaker (Clarke & Clarke 1974).

Such an emphasis is paralleled by the results of research into short-term memory in the retarded subject. It has been suggested (Belmont & Butterfield 1969) that observed deficiencies in performance should be attributed to acquisition processes. It is argued that the acquisition strategies employed by the retarded subjects, in a memory task, are less efficient than those employed by the normal subject.

Perhaps the strongest evidence against the simple 'slow development' theory is the demonstration of qualitative differences between different populations of the mentally handicapped. If DS children can be differentiated on behavioural criteria from other mentally handicapped children of equivalent measured Mental Age, then the purely quantitative account of the handicap cannot be adequate. O'Connor & Hermelin (1961) presented evidence that such differentiation could indeed be made. They found that when compared to other mentally handicapped subjects of the same chronological age and equivalent measured MA, the DS subjects demonstrated inferior performance in a stereognostic (haptic) recognition task. The relevance of such findings to cognitive development is not yet clear; however they suggest that, at the least, there might be qualitative differences in processes mediating performance on cognitive tasks. It begins to appear unlikely, then, that the patterns of performance on cognitive tasks will be accounted for by a 'slow development' theory alone.

Certain studies will now be considered which are concerned specifically with DS infants. It will be argued that the findings support the contention that 'qualitative' differences in behaviour

are of more central importance than 'quantitative' ones (i.e. delays).

Serafica & Cicchetti (1976) studied the attachment behaviour of $2\frac{1}{2}$ year old DS infants. The procedure used was a standardised one, in which the infant was introduced to a strange room with his mother, who then left the child alone and subsequently re-appeared. It was shown that, compared to age-matched controls, the DS infants exhibited less distress at the mother's absence, and less positive attachment behaviour at her re-appearance. Thus they appeared to be manifesting lower levels of attachment behaviour (although of an appropriate kind). The authors argued that the DS infants were not acting like younger, normal infants (as a purely quantitative theory would predict). The behavioural responses which the normal controls made (e.g. locomotion to mother at her re-appearance) were within the DS infants' repertoires. They were not however deployed in this context. It is, perhaps, not possible to distinguish between 'strength of attachment' and 'intensity of manifestation of attachment' within this paradigm. The exact locus of the difference cannot therefore be identified. However the qualitative nature of this difference is clear.

Qualitative differences in attachment behaviour have also been established for the nature of crying. Freudenberg et al. (1978) showed that the cry of the young DS infant can readily be discriminated from that of the normal infant. The cry of the DS infant is perceived as of less intensity, and thereby less demanding of the caretaker's attention, than that of the normal infant. The findings of Jones (1977), relating to the nature of pre-verbal communication in the

mother-infant dyad, may also be seen to have relevance to attachment. Jones (1977) found that there was less eye-contact for the mother-DS infant pair than for the mother-normal infant pair. In general, much less sophisticated communication skills (such as turn-taking) were exhibited by the mother-DS infant dyad. The relationship between such communicational differences and those related to affective behaviour is unknown. Either might, perhaps, be posited as an antecedent of the other.

Cicchetti & Sroufe (1976) studied the development of smiling and laughing (to a variety of stimuli) in seven DS infants. The authors present data on infants' responses to each stimulus at each month of age, from 4 - 18 months. The stimuli were divided into four categories: auditory, tactile, social and visual. It was found that DS infants were less likely to laugh at items eliciting laughter in the normal infant, but would rather smile. Further, the likelihood of a positive response to an item was always at least four times as great for the normal infant, across the age-range. Against this background of population differences, some communality in developmental pattern was found. The order in which different items were first responded to in a positive fashion was, broadly, the same for the two populations. In this respect, findings were analogous to those resulting from the Piagetian approach (above 2.3). There, the order of emergence of 'stages' was found to be similar between DS and normal children. Thus, when development is defined in terms of age-related achievement, it is found to be broadly similar across the two populations. More precise investigation makes it possible to reveal differences.

Smiling in infancy has been taken as a manifestation of cognitive processes (Watson 1972; Bower 1977b) as well as of affective states. The convergence of findings concerned with smiling, and those concerned with cognitive development as such, must be seen as giving rise to a general conclusion. The empirical justification for a theory of 'slow development' needs to be much stronger than is the present evidence. Similarity across populations in terms of gross aspects of development is not an adequate demonstration. The fact that closer investigation tends to find population differences must be seen as a challenge to the theory. It would appear, then, that on empirical as well as theoretical grounds a theory of 'slow development' is not adequate to account for the effects of mental handicap in the DS infant.

3. Conclusions : Aims of the Study

It has been shown above that a 'slow development' theory of cognitive development in the DS infant needs to be expressed in a finely detailed way to avoid circularity. Such fine detail is available only within the Piagetian version of the theory. In the psychometric version of the theory the account of development is expressed in terms of sequences of criterial behaviour - i.e. of 'milestones'. Such an account - whether it be of motor, 'mental', or cognitive development - can only be a description of the observed phenomena of development at a certain level of analysis. It can, therefore, describe only the effects, and not the causes, of deviance in development.

Complementary to the more positive nature of the Piagetian account - in avoiding problems of circularity - is the necessity for appropriately stronger evidence to support it. Thus the demonstration of slow emergence of 'cognitive milestones' would not be sufficient proof of the Piagetian position. It would merely justify the descriptive use of the term 'slow'. If, however, in addition, it could be shown that the context of such 'milestones' is equivalent in the DS and the normal infant, then the strong and non-trivial Piagetian position would be given support. A first example of such equivalence of 'context' would be the same association of criterial successes with characteristic errors as is the case with the normal infant. A second would be the demonstration of equivalent 'representativeness' of the criterial passes for the DS as for the normal infant, in the sense that specific criterial behaviours, once observed to have emerged, would remain in the behavioural repertoire. In general, there are a number of qualitative aspects of behaviour on cognitive tasks which must be shown not to differ between the DS and the normal in order for the Piagetian version of the 'slow development' theory to be substantiated. If the two populations are in fact equivalent in these terms then the age of emergence of a sequence of achievements can indeed be taken as an accurate index of cognitive development.

As was made clear above, there are reasons for doubting that the two populations are equivalent on the qualitative aspects of behaviour under consideration. If these doubts are substantiated, then it would not be possible to accept the Piagetian version of the theory as

anything more than a broad description of the phenomenal aspects of deviant development. However, because of the detailed nature of the Piagetian approach, it would be possible to proceed beyond such a position. The empirical and conceptual richness of the Piagetian account would enable further investigation of the obtained qualitative differences to be carried out. A positive step would then have been made.

Before giving an outline of experimental aims, consideration should be given to the kind of theory which might replace 'slow development' as an explanation of mental handicap in the infant. Mention has been made (p. 26) of one approach to the problem of mental handicap - that of Zigler (1969, 1973) which, it was argued, shared the inadequacies of any 'slow development' theory. Zigler's 'developmental' theory is explicitly opposed to the more classical 'deficit' theories of mental handicap. These latter approaches emphasised absolute differences between the handicapped and the normal populations, frequently postulating neurological defects as their basis (e.g. Benda 1969). Such approaches have no place for developmental findings. The affected individual is, quite simply, 'defective', and the defect is seen to operate in a constant and relatively straightforward manner throughout the life-span.

It would certainly be inaccurate to claim that present-day 'difference' theorists retain such a rigid approach (see Ellis 1969). It is recognised that differences are complex, and require explanation in precise behavioural terms. However, with respect to the developing handicapped child the polarity between 'developmental' and 'difference' theories remains. The conceptual inadequacies of the former have been

outlined in this Introduction. It has been argued that differences in development must have a place in an adequate theory. The insights of modern developmental psychology must, however, make an equal contribution. Population differences must be expressed within the context of the cognitive development of the infant and child. Behavioural outcome must be seen as resulting from an interaction between the handicap and the common processes underlying development. Within such a theoretical approach - which might be termed a 'developmental difference' theory - both similarities and differences in development would have a place. It was hoped that the investigation of cognitive development in the DS infant, to be undertaken in this thesis, would make a contribution to such a theory.

On the basis of the above considerations, then, it was decided to study the cognitive development of the infant with DS, with specific reference to 'object permanence', in comparison with that of the normal infant. This study was to be carried out, at least partly, on a longitudinal basis. Analysis of performance was to take account not only of criterial success on the tasks used for assessment, but also the distribution and nature of failure. If analysis were to reveal differences between the two populations, an attempt would be made to investigate such differences further.

Before commencing this investigation, certain preliminary experimentation with both populations was considered to be necessary. This work is presented first, in the chapters which follow.

CHAPTER II : PRELIMINARY EXPERIMENTATION WITH DS INFANTS

(Experiment 1)

1. Introduction

As noted in the previous chapter, it was anticipated that qualitative differences in behaviour might well be encountered between the DS and the normal infant, in the context of cognitive development. Before undertaking a large-scale study of DS infants, therefore, it was decided to perform some initial, exploratory work with one or two DS infants. It was hoped that such work would make clear some of the qualitative features of behaviour to which attention would have to be given in subsequent work. It was also considered possible that some initial data might be obtained which would address itself to the evaluation of the Piagetian version of the 'slow development' theory.

2. Subjects

Contact was made with the Welfare Officer of the Edinburgh branch of the Scottish Society for the Mentally Handicapped. The mothers of two young children with Down's Syndrome expressed willingness to make a visit to the laboratory with their child.

Both children were boys: S_1 (aged 2 years 5 months) and S_2 (aged 3 years 3 months). Neither child had secondary or associated physical handicaps. S_2 could not strictly be described as an infant, in view of his age and his possession of a few words. However, a review of the literature (Chapter 1) had suggested that DS children of up to school-age might well be found to function within, and not beyond, the sensorimotor period as defined by Piaget. The selection of these

two children as subjects therefore seemed satisfactory.

3. Procedure

A description of apparatus and materials will be given first. Then a description will be given of a selection of tasks designed to make possible the assessment of the infant's performance in terms of the Piagetian account. Both these sections are of general relevance to the experimentation presented subsequently.

3.1 Apparatus and Materials

The child sat on his mother's knees at a table, overall dimensions 87 cm. x 60 cm., from which a semicircle (radius 19 cm.) had been removed on one side. The child was thus able to sit with the tabletop surface to his left and right, as well as in front of him. The tabletop was made of non-reflective matt chipboard.

Occluders consisted of white cardboard cups, height 8.0 cm. and white cardboard screens, size 12.0 cm. x 10.5 cm. which were kept upright by a ledge, folded back at the base, of width 2.5 cm.

Objects used were small, brightly coloured toys.

3.2 Standard Tasks

A summary of the behaviour patterns characteristic of Piaget's six stages for the development of the 'Object Concept' was given above (p. 7). Here standard tasks relating to these different stages will be described. More complete procedural descriptions are given below (Chapter III : 2) when the first large-scale study is presented. Discussion will also be made below of various aspects of the tasks, in

view of experimental findings. This set should be seen as an operational form of the sequence described by Piaget (above, p.7). The Piagetian stage appropriate to success in each task is given in brackets.

1. Retrieval of object partially concealed by occluder (III)
2. Retrieval of object totally concealed by occluder (IV)
3. Retrieval of object from total occlusion at two different locations ('A' and 'B') in the order AAB (V)
4. Retrieval of object from one of two identical occluders following transposition of the two occluders (the 'Switching' task developed by Aronson and by McGonigle; equivalent to VI)
5. Retrieval of object from total occlusion following non-visible displacement. This displacement is carried out by concealment of the object in a second occluder (e.g. an inverted cup) which deposits the object behind the first occluder and is returned empty. Its emptiness prompts the infant's search which, if successful, is argued to have involved a kind of 'deduction' (VI)

Several points should be noted concerning these tasks. Forms of error response may be described which would be as informative as the success patterns given here. For Task 3, the search pattern of AAA to the concealment pattern AAB is referred to as a 'Place Error' (see Bower 1974, p.183). For Task 4, consistent search for the object at its location of concealment - without transposition being taken into account - might be predicted for an infant in 'Stage V' (see below, Chapter VI 4.2.2).

3.3 Presentation

The four tasks indicated by 2 - 5 above were presented to both infants. Tasks 2 and 3 were presented twice each, with both cups and screens used as occluders. Task 1 was not presented since it was

considered that, for the purposes of this pilot study, the results of Task 2 could be taken to cover the problem represented by Task 1. Retrials were given for loss of attention to the tasks. The tasks were presented in the order given above (i.e. in order of assumed increasing difficulty).

4. Results

Results on the tasks are presented first (Table 1). Some qualitative features of the infants' behaviour - against which background the results must be seen - are discussed next.

TABLE 1 Results (Experiment 1)

Task (see text)	Trial/s	S ₁	S ₂
2 (a) cup	1	pass	pass
(b) screen	1	pass	pass
3 (a) cups	AA	pass	pass
	B	no response	error
(b) screens	AA	pass	pass
	B	pass	pass
4	1	error	pass
	2	(omitted)	pass
5	1	no response	pass
	2	no response	pass
	3	pass	(omitted)

Note: 'error' indicates search at incorrect occluder

Results are presented in a 'raw' form. Little data reduction or analysis can be performed on such raw data due to the small number of subjects and of trials and the absence of normal controls. However, certain features should be noted. Both S_1 and S_2 passed the AAB task once with screens as occluders; both failed the formally equivalent task with cups as occluders (S_2 with the characteristic 'place error'). At first glance, a direct assignation to a 'stage' would seem to present difficulties. Further, S_2 passed two trials of Task 4 after both a pass and an error on Task 3. Again, a simple stage model would not predict such response patterns.

The results of Task 5 confuse the picture further. S_1 gave one correct response out of three, having committed an error on Task 4. S_2 gave two correct responses out of two: making even more difficult the interpretation of his error on Task 3. (It should be re-emphasised that this error was indeed a positive response - not a failure to respond).

Clearly this data can only be taken as suggestive. It might suggest, however, that the kind of cohesiveness in response assumed by a 'stage' analysis is not in fact characteristic of the DS infant. In this case, the assignment of infants to 'stages' on the basis of their pattern of results might be problematical. Such assignment - or 'diagnosis' in Piagetian terminology - would not then give an adequate representation of the infant's behaviour. As was noted above (p. 29) such factors would seriously challenge the adequacy of the Piagetian version of the 'slow development' theory.

The apparent lack of coherence in response was accompanied by further striking features of behaviour. Considerable encouragement was required to elicit responses from the DS infants. Numerous retrials were required due to loss of attention during a trial. As may be seen from Table 1, it was not found possible in the 20-minute period to administer the full number of trials. This was not due to individual responses being slow. It was found difficult to maintain the subject's interest in a task over trials.

In general then, impressions gained from the administration of the tasks complemented the tentative interpretation of the results. Rather than the behaviour and performance of the DS infants resembling that predicted of normal infants (irrespective of absolute level of achievement) there would seem to be qualitative differences. Such differences would operate at a level of analysis prior to the assignment of infants to a 'stage', and might therefore render such a procedure inappropriate.

5. Discussion

The aim of this initial study was to establish whether it was reasonable to predict qualitative differences in the performance of the DS infant on cognitive-developmental tasks, in comparison with the normal infant. In this study, as in much that follows, results were obtained in the form of a pass or fail on a given task. It has been noted above (p. 4) that, since Piaget, such data cannot be considered completely satisfactory. It was hoped that this methodology would be of sufficient precision to reveal certain differences between DS and normal infants. If possible, further comparison would take account of such features as the nature and distribution of errors. It would seem that qualitative differences are indeed to be observed. Two areas of behaviour are highlighted. First is the child's general orientation to the situation, and his degree of attention and interest in the tasks. Such features are,

though difficult to measure, of great significance when interpreting the results of experimentation. They must also be taken into account in designing appropriate experimentation. In particular, any apparent difficulty in maintaining attention in the tasks must demand flexibility in presentation on the part of the experimenter. Further it is unlikely that long sequences of identical trials could be presented to the infant within a practicable length of time. These factors will be discussed further below (Chapter IV) in describing the design of more extensive experimentation with DS infants.

The second area of behaviour is the pattern of responses elicited from the infant, irrespective of the procedural difficulties in such elicitation. It was argued that an evaluation of Piagetian predictions for the development of the DS infant must be made on the basis not of single results alone - i.e. of achievements - but on the basis of the constellation of results on different tasks. If the overall pattern of responses of the DS infant differed from that of the normal infant, then an interpretation of a DS child's performance as 'equivalent' to that of a normal child at a certain younger age could not be adequate. 'Slow development' could not then be a tenable theory within the Piagetian framework; instead more detailed investigation of the differences in performance would be required. The results reported for this initial study suggest that there may indeed be major deviations from the kinds of pattern predicted for the normal infant. In view of this, it was decided that further investigation was justified.

CHAPTER III : PRELIMINARY EXPERIMENTATION WITH NORMAL INFANTS

(Experiment 2)

1. Introduction

1.1 Aims of the Experiment

The preliminary work with two DS infants suggested that certain features of their cognitive development might well differ from the normal case. It was decided that the findings justified further investigation of these differences.

Before beginning a large-scale investigation of DS infants, however, it was decided to conduct a further preliminary study, but with normal infants. As will be explained below, certain aspects of the design of the DS study - chiefly methodological ones - demanded some prior investigation. First, the preliminary work had made it clear that presentation of tasks to a DS subject would have to be flexible. It might not be possible to follow a standard order of presentation, without leading to attrition of responses. Usually, a set of cognitive-developmental tasks is presented in increasing order of difficulty (a practice derived from the psychometric tradition). It might instead be necessary to deviate from this order. Certain methodological problems arise from this, which are discussed below, and some investigation of this feature was considered necessary.

Second, it was decided to test out the specific tasks which were intended to be used subsequently with the DS infants. As will be discussed below, several of these were variations on standard items, on which normative data was not available. Further it was not known to what extent these items formed an ordinal set, on which a developmental pattern could be observed.

Third, it was considered that autonomic responses might usefully be taken simultaneously with behavioural responses in the object permanence tasks. This procedure might make it possible to disambiguate behavioural responses. For example, behavioural inactivity might be accompanied by autonomic indications of startle. The subject might then be said to be surprised at some aspect of the presentation (such as the non-appearance of an object where expected). As described below (p. 50) the recording of heartrate has been employed for the purposes of recording autonomic responses simultaneously with behavioural observation. Such a procedure presents certain practical and methodological problems. It was considered that a decision on its adoption for DS infants should only be made after investigation with normal infants.

For these reasons, a short study with normal infants was designed.

1.2 Ordinality of Items assessing Object Permanence

As noted above, the first aim of the study was to assess the effect of non-standard orders of presentation of items. The question of ordinality in the sequences described for cognitive development is an important one. Piaget (1972, p. 50) defines 'constant order of succession' as an essential characteristic of a stage sequence (that it is not a sufficient condition for a stage analysis has been noted above, p.28).

Several statistical techniques are available for the assessment of ordinality. Most commonly used (e.g. by Uzgiris & Hunt 1975) is a version of Guttman's Scalogram Analysis developed by Green (1956). This technique takes the binary results of a number of subjects on a number of items, and, having established the overall order of difficulty of the items, finds how completely this pattern accounts for responses.

Thus if the order of difficulty is the same across all subjects, then any subject's complete response profile may be obtained merely from knowing the first item that was too difficult for that subject. He would have passed all the easier items, and failed all the more difficult ones. To the extent that the 'reproducibility' of the data cannot be performed perfectly in this manner, perfect ordinality has been departed from. Significance of the reproducibility of a given order is ascertained by comparison with 'chance' reproducibility of results (given the total passes for each item, but not the association within subjects).

The application of this technique to developmental data presents certain theoretical problems. If all subjects receive all items, then a legitimate assessment of order of difficulty for those items can be obtained. It should however be pointed out that such an order cannot be identified with an order of emergence in a single infant (although it may well be, in fact, the same). With a cross-sectional sample at different ages it may perhaps be taken as a good approximation of an order of emergence. The special nature of the age variable in developmental research, emphasised by Wohlwill (1973) must not be lost sight of. It cannot be assumed that for one item to be 'harder' than others necessarily implies that its spontaneous emergence will take place later.

Scalogram Analysis proceeds by assuming an overall sequence of items, and assessing its power in terms of observed deviations from it. An alternative approach is to build up a sequence from the relationships between pairs of items. Such a procedure avoids the vulnerability of Scalogram Analysis to inaccuracy with small numbers of items where the

reproducibility due to chance is often extremely high. Such a small number of items is often unavoidable when testing infants (since all responses are required within a single session).

Bart & Krus (1973) have described an extension of Guttman's Scalogram Analysis which establishes scalability between pairs of items rather than for the whole set of items at once. They point out that the relationship between a pair of items, such that Item J is never passed unless Item I is passed, may be interpreted as 'I is prerequisite for J'. This type of relationship is of considerable theoretical importance to the study of cognitive development (Flavell & Wohlwill 1969).

Bart & Airasian (1974) have described the application of this analysis to a set of items derived from Piagetian theory. They point out that Scalogram Analysis is limited to the identification of 'linear hierarchies', in which items represent distinct points along a single dimension. More complex relationships between items will not be uncovered. With an Ordering Theory analysis, however, a picture of the structure of the whole set of items is built up from the relationships between pairs of items, and thus a more complete description is possible.

For each pair of items, the number of subjects who responded differentially to them is noted (divided into two cells according to the direction of difference). If the values are markedly different, e.g. many (I+, J-), few (I-, J+), then a prerequisite relationship may be posited between the two items. The significance of such a result may be assessed by calculating the lower of the two values (that disconfirming the relationship in the posited direction) as a percentage

of the number of subjects. Bart & Aurasian (1974) suggest a value of 5% as the criterion for significance.

Significant directional relationships may be plotted on a 'tree' diagram. Where relationships between items are not significant in either direction, the items are regarded as equivalent. To the extent that relationships are congruent, a single 'tree' structure showing the relationships amongst items may be constructed. In such a structure, 'prerequisite' relationships will be transitive. Thus (if this relationship is indicated by *), for $I*J$ and $J*K$, it can be asserted that $I*K$.

The most rigorous investigations of the ordinality of items in the development of the Object Concept have been those of Miller et al. (1970) and Kramer et al. (1975). The earlier study selected 15 items from the Object Permanence scale of Uzgiris & Hunt (1975) and presented three groups of 8 items each (the first, middle and last 8) to infants between 6 - 18 months. Miller et al. studied the degree of ordinality obtaining within the set, both when presented in the expected order of difficulty and when presented in a random order. The latter condition is of interest since 'developmental' tests are usually presented in 'developmental' order, and it might be argued that high ordinality may be artificially enhanced by fatigue and lack of interest during the presentation of later items.

Miller et al. found minimal evidence for ordinality in the 15 items in either condition. The authors, however, noted that the results may have been influenced by such factors as the specific selection of items and their division into sets of 8 across different groups of subjects. Kramer et al. (1975) improved the design by reducing the number of items

to six, and presenting each to each subject. Presentation order was balanced by means of a Latin Square design. No subject, however, received items in the order of predicted difficulty. In addition, a longitudinal component was included in the design. With these modifications, high ordinality for the six items was obtained across subjects.

It was decided to use a similar design to these studies in order to investigate a slightly different set of tasks. The nature of the items will be described below, and comparison with those of the previous studies will be made as appropriate. In general, the items were those which were hoped to be used in further work. In view of the considerations expressed above concerning the constraints on the design of items for a scaling analysis, certain modifications of the items were made to increase the uniformity of situations and materials across items. This will be made clear when the specific items are discussed.

1.3 The Use of Heartrate Change as a Dependent Measure

The possibility of using autonomic responses as an objective measure of behavioural change has always been an attractive one. Cardiac changes have long been implicated in psychological states such as startle and orientation. Classically, heartrate deceleration (HRD) has been associated with the 'intake' of information, and heartrate acceleration (HRA) with the 'rejection' of input. In relation to Sokolov's analysis of autonomic function, the two types of changes have been associated with the 'Orientation Reaction' and the 'Defence Reaction' respectively (Graham & Clifton 1966). If the binary response

is a reliable one, with respect to known environmental features, then recording of heartrate would seem to offer a dependent measure of great value to the study of infancy, with its relative paucity of response modalities.

The kinds of cardiac change observed in neonates have so far been exclusively HRAs (Graham & Jackson 1970). However, during the first half-year HRDs begin to be observed, even substituting for previous HRAs in identical situations in the neonate (Graham & Jackson 1970). For example, 6-month old infants respond with HRDs of 3 - 9 beats/min (bpm) to the onset of visual or auditory stimuli (Lewis & Spaulding 1967), a response interpreted as 'orientation'. Investigation of the HRD response in infants has been carried out by Lewis (1975) who has traced developmental changes in the response to onset and offset of presented stimuli. Despite noting the kinds of event which might induce HRA (such as startle), Lewis offers no data on this kind of response.

The importance of 'surprise' as a behavioural response has been emphasised (Charlesworth 1969), and the apparent relationship between 'surprise' and 'startle' would seem to suggest the use of cardiac response within the study of cognitive development. This has been done successfully by Bower (1971). In this study, as in those interested in HRD, the infant was relatively passive while various displays were presented. The possibility of using heartrate response as a measure when the infant is active - as in a standardised testing of Object Permanence - remains open. The effect of ongoing motor activity on cardiac responses is not clear (Graham & Jackson 1970). As these authors note, most experimentation has been carried out on



'drowsy subjects'. However, in view of the importance of judgements of surprise in the analysis of results of object-permanence tasks, the possibility of using HRA as an objective measure would seem to be worth investigating. This study was also designed, then, to offer some tentative evidence on this possibility.

2. Items Selected for Presentation

As will be noted, the set of items was broadly similar to that used in Experiment 1 (see p. 40). Where new items are introduced or changes in presentation made, appropriate discussion is given. For each item an operational description of procedure is given. In this description, 'A', 'B' refer to different positions without specifying absolute location. 'L', 'R' refer to locations (or directions) to the infant's left and right, respectively. Where a set of presentations is separated by '&', both were given in a random order. The random choice between two orders is indicated by '/'. 'O' refers to the object used, 'S' to the subject and 'E' to the experimenter.

Item 1: The 'AAB' task described above (p. 40) is concerned with the infant's response to an object's being hidden in a new location, after having been successfully retrieved from an old one. The first two trials may be seen as tests of Piaget's Stage IV of object construction (see p. 7), in which a single location is used for concealment. O was moved by E, in full view of S, from the midline position to a location behind one of two vertical screens where it was left hidden for S to retrieve. Presentation : RRL.& LIR.

Item 2: It was found by Miller et al. (1970) that the retrieval of an object after a continuous sequence of visible displacements was at a higher level of difficulty than retrieval following a single non-visible displacement. This finding contradicted the results of Piaget (1955). It was decided to test this by employing a similar task to that used by Miller et al.

O was moved by E from a position to one side of S along a path behind the first of two separate vertical screens, appearing between them, and being left concealed behind the second. Presentation : O starting from RLLR/LRRL.

Item 3: The 'Switching' task in which two inverted cups (one of which contains the object) are transposed, was described above (p. 40). In order to make the materials more consistent across tasks, however, screens were used instead of cups, as occluders. The ledge which supported the screen in an upright position served also to carry the object, when the position of the screens was transposed.

O was placed on the supporting ledge of one screen and the two screens transposed by E. Presentation : O starting from RLLR/LRRL.

Item 4: The 'deduction' task described above (p. 40) was included, using the same materials of an inverted cup and two screens behind which objects were transported while inside the cup. O was placed in front of S, and an inverted cup placed over it. By moving the cup, E deposited O behind one of two vertical screens, and returned the cup to a position in front of S.

It was then shown, empty, to S. Presentation : O deposited to LLR & RRL.

Item 5: This item was designed following some observations of Watson (pers.comm., 1976). He noted that, in certain tasks concerning the use of 'deduction' infants' interpretation of the picking up of an object by a container during its trajectory (from a location behind a screen) seemed to be such that the 'capture' was seen as obligatory, rather than optional. Further, it seemed that 'capture' was predicted even when physically impossible, for example when the moving container was merely placed in contact with that containing the stationary object. If such notions of 'obligatory capture by contact' are indeed operative, then the performance of the infant in a standard 'deduction' task (such as Item 4 above) might well conceal important deficiencies in understanding. Item 5 was therefore designed to test 'obligatory capture by contact'. O was placed behind a vertical screen in front of the infant. An inverted cup was then moved across from one side. On two occasions it picked up O and was moved further across and left at the new location. On the third occasion, the cup was moved across to a position in front of the screen. After a pause of 1 sec. the trajectory was continued as on earlier steps. This third step was therefore a 'catch'. Presentation : cup starting RRR & LLL.

General As can be seen from the descriptions of the items, the materials and procedure were standardised as much as possible, especially for Items 1 - 4. Each of these items includes the movement of the object (either visibly or invisibly) and the use of similar occluders, namely the vertical screens. The items are numbered in the assumed order of difficulty; there is, however, little evidence for the relative ranking of Items 3 and 4, and Item 5 is placed last because if the effect tested is real, it could presumably be operative while both 3 and 4 are passed.

3. Procedure

3.1 Subjects

Subjects were 26 normal infants, 2 of each month of age from 6 - 18 months inclusive. These subjects were drawn from a pool consisting of infants whose parents had expressed willingness for them to participate in research studies. Some degree of selection must operate on this pool, and the infants probably constitute a sample of above average measured intelligence (as assessed at pre-school age; see Wishart 1979). However, such deviation from representativeness of the normal population was not considered significant.

3.2 Method

First the device for continuously recording S's heartrate was set up. Two electrodes were applied to S, one on the sternum and one on the left side of the abdomen. These were connected to a transmitter

taped down to S's chest. The signal was picked up by an FM receiver, and recorded on tape. This apparatus eliminated the need for leads connecting S to recording equipment, thus allowing greater freedom of movement.

S was then seated on his mother's knees at a table as described above (p. 39). The entire session was videotaped for subsequent analysis.

The series of items was presented to S. For each pair of Ss in a month of age, one was assigned to the 'Ordered' (O) and one to the 'Balanced' (B) condition. Ss in O were presented the items in the order 1 - 5. For B, the order of items was balanced as follows: 24 orders were obtained, with Items 1 - 4 in all combinations, and Item 5 distributed equally at all locations. 12 of these were selected at random for B Ss.

Retrials were given if there was loss of attention on the part of S. For each trial, S was allowed 10 secs. in which to make his response.

3.3 Materials

Materials were identical to those described above (p. 39).

3.4 Scoring

Criterial response for each trial was the direct retrieval of the object by S, by removal of the appropriate occluder, within 10 seconds.

Data was reduced as follows for the purposes of analyses of ordinality. A '+' score was given for an item if all trials were passed. Otherwise, a '-' score was given. Such a binary score is

necessary for these forms of analysis. Raw data (individual responses for each trial) were retained for the purpose of further analysis.

4. Results and Discussion

Since there were several distinct issues with which the experiment was concerned, results and discussion will be presented together for each issue. Following this, a general discussion will summarise the overall findings.

4.1 Ordinality

4.1.1 Balanced versus Ordered Presentation

Overall results are presented in Table 2. It can be seen that, under the Balanced and the Ordered conditions respectively, totals of 14 and 11 passes were recorded. This difference is not statistically significant ($\chi^2 = 0.16$, $df = 1$). It is clearly not the case that the Balanced presentation leads to a distortion of performance. In view of this finding, results from subjects in the two conditions will be pooled for subsequent analysis.

TABLE 2 Overall Results (Experiment 2)

	Item 1	Item 2	Item 3	Item 4	Item 5	Total
Passes recorded:						
Condition O	7	4	0	0	0	11
Condition B	5	5	1	3	0	14
Total (Overall Preference)	12	9	1	3	0	25
Age (months) first pass recorded	10	10	17	11	-	

4.1.2 Ordinality for the Set of Items

As was noted above, there are two available methods for assessing ordinality - Scalogram Analysis and Ordering Theory Analysis. Both were carried out. As may be seen from Table 2, the obtained order of preference of items (in terms of total number of passes across subjects) was the order 1, 2, 4, 3, 5. It was with respect to this order that Scalogram Analysis was applied. Infants in the age range 6 - 8 months inclusive were omitted from the analysis, due to their total set of '-' scores. Including these results might have spuriously inflated the value for reproducibility (by increasing sample size without making possible instances of deviation from the tested order).

Reproducibility for this order of items was 0.97. It should be noted that the reproducibility due to chance is high for small samples. Green (1956) describes the estimation of significance by calculation of the parameter 'I' from the values of both reproducibility figures. A value of I greater than $\frac{1}{2}$ is taken to indicate true ordinality on behalf

of the items. In the present case, $I = 0.58$. The order of the items as 1, 2, 4, 3, 5 can therefore be said to accurately represent the order of difficulty of these items across subjects.

Ordering Theory (Bart & Krus 1973) analyses the relationship between pairs of items. Results are presented in Figure 1. Here a single-headed arrow between two items indicates that, within the 5% level of significance, success on the 'origin' item was an operational prerequisite for success on the 'insertion' item. It will be noted that Items 1, 4, 3, 5 form a continuous branch which, due to the operation of transitivity, may be considered as a single linear dimension. Clearly this finding corroborates that of the Scalogram Analysis. However, Items 1 and 2 are found to be equivalent in terms of prerequisite relationships with each other and the other items.

FIGURE 1 Results of Ordering Theory Analysis (Experiment 2)



Key:

- $I \rightarrow J$: I 'prerequisite for' J (at 5% level of significance)
 $I \leftrightarrow J$: I 'equivalent to' J (difference N.S. at 5% level)

4.1.3 Discussion

Both methods of analysis demonstrated that the order of difficulty of the five items was as originally predicted, except that the order of Tasks 3 and 4 was reversed. If the fundamental aspect of Piaget's Stage VI (Piaget 1955) is the ability to follow non-visible displacements of an object, then Item 3 would seem to test this directly, while Item 4 includes an extra element - the need to make a deduction. That the abilities assessed in the 'switching' task are prerequisite for deduction tasks has been assumed by Bower (1974a,p.213). A valid finding of a reversal of this ordering would therefore be of some importance.

However, some of the video records showed clearly that some infants credited with success on Item 4 had not, in fact, made use of 'deduction' from the empty cup. Instead, such infants had reached for the correct screen directly. At most, a glance had been given to the cup. No search (either manual or visual) could be said to have been made in the empty cup. It could not, therefore, be concluded that the reach for a screen had been made on the basis of the object being absent from the cup. Solution of the problem had not involved the use of deduction. Instead the abilities assessed by Items 1 and 2 would appear to have been adequate.

The fact that some subjects had employed 'deduction', and some had not, gave rise to a heterogeneity in responses to the task. This concealed heterogeneity in the responses for Item 4 may well account for its placement (in the analysis) at a higher level of difficulty than 1 and 2. It is clear, however, that the theoretical account given above,

concerning the status of the 'deduction' task, is not seriously challenged by these results.

Item 2 was designed on the basis of the proposal by Miller et al. (1970) that a sequence of visible displacements would prove more difficult than a single one (as in Item 1). The support for this assumption given by the Scalogram Analysis of the whole set of items must be qualified by considering the results of the analysis of individual pairs of items. The status of Item 2 in relation to Items 3, 4, and 5 is as predicted but no significant relationship can be found with Item 1. It must therefore be considered to be equivalent in terms of difficulty. No significant additional skill appears to be required for its solution. The lower preference obtained for this item must therefore be attributed to less central factors. This conclusion agrees with that of Kramer et al. (1975) in their failure to replicate the findings of Miller et al. (1970) with respect to sequential visible displacements.

In assigning a predicted status to Item 5, it was argued that error (the operational anticipation of 'capture by contact') would not preclude success on the other items (notably Item 4) and thus the item should be placed highest in difficulty. Insofar as the analyses of ordinality bore out this prediction, this argument can be said to have been justified. Since this item was original and to some extent distinct from the others, further consideration will be given to the specific results below. First, however, some general points will be made with respect to the procedure of the assessment of ordinality.

In this study an attempt was made to devise a set of items with as much similarity as possible amongst non-critical features of presentation. The more it is the case that successive items on a well-scalable series differ only in one critical feature, the more justified is the inference of a single underlying dimension (see Wohlwill 1973). In the present study then, such a conclusion could be tentatively asserted.

With respect to the relationships between pairs of items, rather than to the set of items as a whole, similar caveats apply. The empirical finding that criterial performance on Item I always precedes criterial performance on Item J cannot be said to prove a 'logical' relationship between the two. Such an interpretation must be based on further considerations (mainly of a theoretical nature). However, it can be said that such evidence is of an essentially correlative nature, and interpretation in terms of causation can only be tentative. Such predictions from logical analysis need to be tested empirically (e.g. by acceleration studies, as noted by Bower 1974b). The results of 'order theory' analysis must therefore be considered in the same light as those of the scaling analysis. Good evidence for the orderly emergence of the behaviour is obtained. Explanation for such a finding in terms of unitary underlying structure, can, however, only be tentative.

Finally it should be noted that both of the analyses divided responses in a binary fashion. Thus infants who made a positive error of search on an item were grouped together with those who made no response at all. Clearly this practice reduces the validity of these kinds of analysis. The theoretical framework from which the items were

taken typically specifies two kinds of response to an item. One response characterises success, the other a specific form of failure. This latter - the 'characteristic error' for the task - is predicted for the subject not yet 'ready' to solve the task, who thus applies an inappropriate strategy to it. An example of this is the Stage IV Place Error (described above, p. 40), in which a strategy appropriate to previous stages is wrongly applied to a more difficult task. A strong prediction is being made in such cases, since the exact nature of both success and failure is being specified.

The crucial step in creating a 'test' is to retain the diagnostic value of 'errors' and not to rely solely on the diagnostic value of successes. To do the latter is to assume that any error will be of the 'characteristic' form. Such an assumption may not be justified. Validation of a scale of criterial success - i.e. achievement - can only be considered weak evidence for the structural theory it attempts to test.

4.2 'Capture by Contact'

4.2.1 Results

No infants passed this item twice out of 2 trials. Adequate performance on the two preliminary steps of the item did not occur before 11 months, after which just over half of the trials fulfilled this condition. In the absence of the correct preliminary behaviour, behaviour on the third (catch) step could not be unambiguously interpreted. Only the 'meaningful' trials are considered below.

With the exception of one trial for a 12-month old, errors for infants of 11 - 15 months constituted a form of the predicted error,

in that the cup was picked up after the catch step. However, such responses were not followed by search of the cup, nor by subsequent search behind the screen. Above 15 months of age, adequate preliminary steps (accounting for 9 out of 16 trials) were followed on 7 occasions by picking up of the cup. This was accompanied by such behaviour as visual or manual search of the cup, 'global' search of the surrounding areas, facial indications of surprise or subsequent search behind the screen to retrieve the object. Such responses were considered to demonstrate the strong predicted error, in that behaviour suggested anticipation of the object's presence in the cup. The other 2 out of the 9 adequate trials included direct search behind the screen on the catch step, thus constituting success. There was no clear age trend in the distribution of these successes and errors.

4.2.2 Discussion

The predicted error was observed in the behaviour of a number of older infants. With younger infants, where the preliminary steps in a trial had been responded to adequately, response to the 'catch' step of this item was frequently similar, in formal terms, to the prediction. However, other evidence (from subsequent behaviour of the infant) suggested that the inferences concerning 'understanding' on the part of the infant - i.e. inferences to structural features of cognition - would not be justified in these cases. In view of the 'expectancy' which can be assumed to have been induced (by the infant's successfully retrieving the object twice from under the cup) the response of picking up the cup was not considered adequate evidence

for the predicted error. This example demonstrates the difficulty of specifying precise behavioural responses which may then be unambiguously interpreted in terms of 'cognitive structure'.

It appears from the results that the specific error cannot be regarded as 'obligatory'. Both trials on which the item was passed by a specific subject were paired with an error on a second trial. It would seem more appropriate to interpret the results in terms of an error which infants (of up to 18 months) may well make: and thus that, for the infant, the physical conditions of the catch trial are not sufficient to preclude the possibility of capture. In other words, evidence has not been obtained that infants (e.g. of a certain age) necessarily infer capture from physical configurations in which it is not in fact possible. However, evidence of a slightly weaker kind has certainly been obtained, to demonstrate that certain features of a task which physically preclude certain results may not be taken by the infant to do so. Therefore it would be erroneous to infer from the successful performance on other tasks that a full understanding of these features had necessarily been acquired. Clearly such evidence is relevant to several areas of investigation: for example, the question of the infant's understanding of spatial proximity and contact. More generally, it is of significance for the ascription of 'understanding' on the evidence of success on specific tasks. If such a task can be solved adequately, while the infant simultaneously demonstrates lack of understanding of certain featural aspects of the task situation, then clearly success cannot be taken to indicate a global 'understanding' of that task. Correct (criterial) solution may be possible on the basis of more task-specific information.

4.3 Heartrate Change

4.3.1 Method of Analysis

It was hoped to obtain complete audio recordings of heartrate for all the subjects. However, the physical activity of the infant during the session created unanticipated technical problems with recording. Transmission of the signal was frequently interrupted, and interference occurred due to the changes in orientation of the two electrode leads during motility (since these leads act as an aerial). A complete analysis of the heartrate changes was not possible. Sufficiently clear recordings were obtained to enable a thorough analysis of two infants' records (one younger and one older infant). Both subjects had been presented with the items in the standard order ('0'). It was decided to carry out a full analysis of these two subjects before making a decision on further analysis.

First the heartrate record was transcribed to paper tape. During this transcription, a manual marker was used to indicate the location of specific events on the visual record, so that correlation between the cardiac and behavioural records could subsequently be made. Having obtained the cardiac trace for the whole session, the information was converted into a series of instantaneous heartrates. This was performed using a standard Dracard heartrate converter, which transforms the linear distance between pairs of peaks into the equivalent heartrate at that point. Behavioural 'landmarks' were transferred onto this record of instantaneous heartrate.

There is no single method of transforming a series of heartrates into 'accelerations' and 'decelerations'. Such analysis depends on specific (quantitative) criteria chosen for such categorisation.

Several alternatives are noted by Lewis (1975). Such factors as the interval over which to measure, the location of this measured segment with respect to the behavioural event of interest and whether to use a constant time interval or a constant number of peaks (i.e. beats) to specify the segment must all be taken into consideration (Lewis 1975).

A common feature of the use of heartrate analysis as a dependent measure has been the sampling of records on the basis of behavioural events. Thus the record is examined specifically to see 'what happened' as a result of the event. Clearly such procedure is open to problems of control, if interpretation in terms of causality is made. The kinds of change observed to co-vary with the behavioural event (e.g. stimulus onset) may also occur in the absence of such events, or to less specific features of such events. In fact, such methodological problems are probably not great when the infant is passive, and stimuli are (for example) being projected onto a screen in front of him. Heartrate between presentations can be expected to be reasonably stable, and inspection of the record is probably adequate to check on this. However, when the infant is physically active, as in the present study, and where the 'events' of interest are being sampled from a complex stream of environmental changes, some methodological control would seem to be essential. Further, the description of clear relationships between kinds of environmental or behavioural event, and kinds of cardiac activity, would by this means be set on a more solid base.

Therefore, it was decided to perform an analysis of the heartrate record which accessed all examples of specific kinds of change during

the session. Within the limitation of the definition of what would constitute a significant change, this procedure would give rise to an independent list of the significant HRAs and HRDs. This list could then be compared with the behavioural record to enable controlled correlations to be made.

A program was written in PSYFOC (a version of FOCAL) for operation by a Linc-8 computer. The input to the program was the series of figures representing instantaneous heartrate. For each consecutive set of $2n$ values (where n could be set by on-line input) the program accessed those sets in which the difference between the mean of values 1 to n , and the mean of values $(n + 1)$ to $2n$ was greater than 5 bpm. Thus the program isolated points (specific beats) around which a significant change of rate occurred. The program printed out the whole set of figures concerned, together with an index number to locate the set in the whole series, and gave the exact value of the difference between means. The values of n chosen were $n = 2$ and $n = 3$. Thus the program obtained and listed, separately, those consecutive sets of 4 and 6 points in which the first and second halves of the set differed significantly in mean value. These specific values were selected after consideration of the criterial differences applied in other studies (e.g. Lewis 1975).

4.3.2 Results

Analysis was carried out on the records of two infants aged 7 months (S_1) and 14 months (S_2). Here a summary of obtained heartrate changes will be presented. Next the manner in which behavioural and stimulus events were categorised will be described. Correlations

between these events and heartrate change will then be discussed.

Both records included both kinds of heartrate change, with a greater incidence of decelerations (HRD) than accelerations (HRA). There was, however, a considerable difference between the overall incidence of significant changes in the two records: 15 (S_1) and 114 (S_2). One reason for this difference may well have been the difference in heartrate baselines (approximately 70 and 120 bpm. for the younger and the older subject, respectively). Since sampling was taken over a fixed number of beats, the time period concerned was different across the two subjects. Further, a higher baseline may well be associated with larger absolute changes in heartrate.

Inspection of the records revealed that a number of significant changes were merely 'returns' of the rate to the base level (after a previous deviation in the opposite direction). These instances were clearly identifiable, and were found to make up 15% and 20% of all changes for the younger and older subject respectively. Such instances were eliminated from further analysis. However it should be noted that this phenomenon might be expected to affect heartrate response in the present context, since a 'new' response might be superimposed on the 'return' from an earlier one. Such problems would not be expected to arise where discrete stimuli are presented to a passive infant.

The record of stimulus and behavioural events was then examined by inspection of the video-tape. For both subjects, this sequence of events was categorised, first, into two broad groups: 'events' and 'activities'. The former included the appearance or disappearance of an object (due to either the subject's or the experimenter's behaviour).

The latter included prolonged regard or manipulation of the object (by the subject). The video record was also examined for instances of 'surprise' on the part of the subject. Judgement was made on the basis of facial expression, with particular attention being given to widening of the eyes and raising of the eyebrows (see Neilson 1977).

Obtained instances of heartrate change were then compared to the categorised behavioural record. These results are presented in Table 3. Over both subjects, 65% of heartrate changes were associated with behavioural or stimulus events (and were thus termed 'meaningful' instances). This result suggests that it is justifiable to assume that real relationships do obtain between environmental events and heartrate changes, in this context. The temporal association of the two kinds of data cannot be attributed to chance alone. It is also clear that such direct relationships do not always hold.

TABLE 3 Instances of Significant Heartrate Change for two Subjects
(Experiment 2)

Subject	Direction of Change	'Meaningful Instances'			Other
		Events	Activity	Total	
S ₁ (younger)	HRA	3	0	3	2
	HRD	1	5	6	4
S ₂ (older)	HRA	0	8	8	25
	HRD	18	49	67	14
TOTAL		22	62	84	45

More detailed study of the relationships between the two types of data was then made. For the younger infant, the small number of obtained changes limited analysis. However, it may be noted that only some 15% of 'events' as described above (relating to the appearance or disappearance of an object) were associated with changes. Of these changes three were HRA and one HRD. All (five) of the changes relating to 'activities' such as manipulation were HRDs. These numbers are of course too small for further analysis, but they are distributed in the manner predicted, with HRA as a possible 'startle' response to the unexpected appearance (or non-appearance) of an object. However, it should be noted that the one instance of facial 'surprise' during the session (to the sudden appearance of an object) was not accompanied by a significant cardiac change. It might be tentatively suggested therefore that HRA and behavioural surprise are both potential elements of a response to certain events, but that they are not necessarily 'triggered' in a determinate fashion by the event nor are they necessarily related as part of a unitary response.

For the older infant, considerably more data was available. Here there appeared to be a clear distinction between the events to which the two different types of heartrate change occurred. HRAs were observed to co-occur only with the 'activities' such as object manipulation or regard, and never with the 'events' related to object appearance. This finding is clearly in opposition to the prediction that HRA should accompany such 'cognitive' stimuli. It should be noted here that the distribution of changes between 'events' and 'activities' cannot be attributed solely to the infant's physical

movement; only 50% of removals of an occluder were accompanied by a change. This fact is also of importance in considering the instances of HRD which co-occurred with both kinds of stimuli. Less than half the HRDs were related to the 'cognitive events' and inspection showed that the pattern of response was similar to that for the 'activities'. This latter finding is congruent with Sokolov's identification of HRD with the 'increased receptivity to information' as noted above (p. 50). Such an interpretation could be referred to in simpler terms as 'interest'. Thus manipulation or prolonged regard of an object may well be accompanied by HRD, and the response to 'interesting' cognitive events may well be identical.

This interpretation is supported by the comparison of changes accompanying facial surprise: HRD 3 times and HRA once (and one instance only of no accompanying change). Thus the evidence from the older infant strongly suggests that the heartrate change to be anticipated when a 'surprising' event occurs is one of HRD, i.e. the 'orientation' or 'interest' response also accompanying visual or manual exploration.

4.3.3 Discussion

The scanty results from the younger infant suggested that acceleration of heartrate may accompany the sudden appearance or non-appearance of an object. Such occurrences may be seen as violating the infant's expectancies (as posited by, e.g. Bower 1974a, p.192). Stronger evidence, from the older infant, suggested that, in this case, HRA was not a common response to events which could be considered 'surprising'. Such instances rather resulted in the response of HRD,

which from its frequent accompaniment of exploratory activities, could be interpreted as an index of 'interest'.

If it is assumed that these results are generally representative, the most obvious explanation would refer to the difference in age of the two infants. The older infant would be expected to have a more sophisticated understanding of the behaviour of objects, and thus to be surprised or startled less readily than the younger. The HRD response of the older infant to potentially 'surprising' events might be seen as a more 'mature' response than would be the startle. However, inspection of the data revealed that, of the eleven occurrences of HRDs to 'cognitive events', 9 took place in the context of items which the infant failed. The infant could not be expected to have made correct anticipations about the object during these trials, and indeed these 9 instances might be seen as ideal examples of incorrect anticipation on the basis of less mature cognitive structure. Therefore, the resulting HRDs present strong evidence against the prediction of HRAs as an index of 'cognitive startle'.

As has been pointed out however, the fact that infants were continuously active during the session had considerable influence on the nature of the data obtained. It may well be that 'implicit' but small HRAs were present in the response to certain situations, but that they were concealed by larger HRDs. Inspection of some of the graphed results of Lewis (1975) suggest that a small HRA may precede a large HRD as the response to the onset of a stimulus.

It would seem then that the strong postulate, that HRA would occur with sufficient reliability to disambiguate behavioural data has

not been substantiated. On the basis of the available evidence (on only two subjects) such autonomous responses would not seem to offer the solution to these methodological problems within the semi-naturalistic context of the present study. Certainly the value of the technique in more highly controlled situations - e.g. with a passive infant and discrete stimuli - is not challenged by the present study.

It should also be noted that there would appear to be definite age-linked changes in the heartrate response to these situations. How these are related (if at all) to the infant's level of cognitive development is not clear. The 'interest' response indicated by the HRD would seem to be present from at least 7 months, and dominant at 14 months. This finding is of interest in relation to the general trend of the replacement of HRA responses by HRD during the infant's first 6 months (Graham & Jackson 1970). More work would clearly be required to delineate these changes. With respect to 'cognitive startle' however, it would seem that the use of heartrate as a dependent measure is more appropriate in the more controlled situation than that which obtains in the assessment of cognitive development. In such contexts therefore, the technique would not seem to offer itself as an instrument for disambiguation of behavioural description. As in other contexts, it seems that behavioural analysis must look after itself, and not seek for validation from physiological measures.

In view of the conclusions derived from the results of the two subjects, it was not considered justified to extend analysis to further subjects. The issues encountered were not central to the

overall aims of the thesis.

5. Conclusions

Extensive discussion has been made above of various aspects of the study. Some of these points will now be summarised, especially with regard to their implications for the design of further research.

There did not seem to be any effect on results from varying the order of presentation of items. It was therefore concluded that any flexibility in presentation which seemed necessary when working with the DS infants could be legitimately employed. In general, the items selected were shown to exhibit a coherent range of difficulty across subjects, throughout the age range studied. One item (Item 2) was found not to present any more difficulty than the more standard Item 1. This task was therefore not used subsequently.

The exploration of heartrate change as an independent correlative to behavioural events did not demonstrate sufficiently clear associations to suggest its subsequent adoption. Especially with the active infant, decelerative 'interest' changes, rather than the accelerative 'startle' response, accompanied those events interpreted as 'surprising'. Such association was not sufficiently reliable to suggest its employment as an arbiter in cases where behavioural evidence was ambiguous. It was therefore decided not to adopt heartrate recording in further study (although it was clear that further investigation could be carried into the relationships present, and the patterns of developmental change). It should also be borne in mind that a proportion of DS infants suffer from congenital heart defect (p. 3). It is not known to what extent such a condition might

affect the reliability of heartrate change measures.

Having carried out the preliminary work reported in this chapter, more extensive investigation of DS infants was designed. This is introduced in the next chapter.

CHAPTER IV : LONGITUDINAL STUDY OF DS INFANTS

(Experiment 3)

1. Introduction

The preliminary work reported in Chapter II suggested that qualitative differences might be found between the cognitive development of the DS and of the normal infant, over and above any differences in attainment at matched CA. It was therefore decided to carry out a larger scale investigation of the characteristics of the DS population, with the hope of obtaining data on such features.

For several reasons it was decided to use a longitudinal design for the investigation. First, the relatively low incidence of DS made it unlikely that cross-sectional samples of sufficient size could be obtained. Second, it was thought likely that certain features of the cognitive development of the infants would only be observed by means of repeated presentation of the items over time.

2. Subjects

As in the previous study, contact with parents was made through appropriate voluntary agencies. In view of the low incidence for DS, approaches were made to the agency covering Glasgow (the Strathclyde branch of the Down's Children's Association) as well as to that covering Edinburgh (Aid for Down's Babies, Edinburgh).

Members of the two agencies (chiefly parents, plus interested professional workers) were first addressed as a group at an appropriate General Meeting. At this time, the general purpose of the study was explained. It was made clear that a series of visits to the laboratory would be involved, over a period of some 8 - 10 months. It was also

made clear that the study had a purely research purpose, and made no claim to be of significant educational benefit to the individual child. Interested parents were asked to make contact. A similar statement and invitation was contributed to the newsletters of the two agencies.

Initially, the parents of twelve infants with DS expressed interest. Since the assessments to be carried out required that the infant retrieve objects and lift occluders from a table-top, a behavioural criterion was introduced to select the sample. Only those infants capable of picking up objects in this way were to be included in the longitudinal study.

Application of this criterion reduced the sample to 8 infants (see Table 4). The subjects eliminated did not solely consist of the youngest of the original 12, and therefore some defence of this procedure should be given. It might be suggested that a more able sub-group of DS infants was being selected. First it should be pointed out that there was no reason to consider the original 12 unrepresentative. The elimination of four infants - including two of under 10 months in age - should not have led to a total distortion of the sample. Second, a point of more general importance should be made. The purpose of experimentation was to look for differences between DS infants and normal infants. If such differences were to be observed with respect to a sample which omitted the most severely handicapped of the DS population, extrapolation of results to this population as a whole would still seem legitimate. It would seem likely that any specification of handicap for the more able would be applicable - with additions - to the less able.

Karyotype information was available for all but one of the eight infants. In all cases full trisomy was present.

TABLE 4 Subjects with Down's Syndrome in Longitudinal Study

Subject no.	sex	Karyotype	Date of Birth	Age (months) at first visit	No. of visits
1	girl	Trisomy-21	21.11.76	12	6
2	girl	"	24. 8.76	20	3
3	girl	not available	24. 3.76	18	9
4	girl	Trisomy-21	20. 3.76	18	5
5	boy	"	7. 1.76	18	9
6	girl	"	14.11.75	20	12
7	boy	"	3.10.75	22	9
8	girl	"	22. 9.75	22	11

3. Procedure

3.1 Location and Organisation of Visits

Infants residing in or near Edinburgh were studied in the same facilities as employed for the research reported above. Facilities were also obtained in the Department of Psychology, University of Glasgow, for the purposes of studying those infants residing in the Greater Glasgow area. In all respects, apparatus and materials were identical in the two locations.

Sessions were generally arranged at 2 - 3 week intervals. In the case of the Glasgow-based infants, it was unfortunately not always possible to rearrange visits if appointments could not be kept since the author could only make periodic (one-day) visits to Glasgow himself. For this reason, attendance over the entire series of sessions was not as complete as might have been wished. A record of total sessions attended is included in Table 4.

3.2 Tasks Presented

The set of tasks used was broadly similar to that used in the previous experiment (Chapter III). Some changes were made on the basis of methodological considerations and the results of the previous experimentation. These changes are noted below.

As noted above, all the items were designed for the 8 infants who would readily pick up small objects from the table-top. Administration and results for infants not in this category will not be considered here.

Tasks fall into three groups: (a) those concerned with a series of visible displacements ('AAB'), (b) those concerned with non-visible transposition ('switching'), (c) those concerned with a non-visible displacement after which the object's absence must prompt the infant to deduce its new location ('deduction' tasks).

(a) AAB task

The standard AAB task was retained. The task involving continuous movement behind two separate screens (Item 2 in Experiment 2) was not retained, since it had been found to be equivalent in difficulty to the AAB task (p.59). As noted above, the AAB task is intended to differentiate between Piaget's Stages IV and V (see Chapter III: 3.2).

Presentation: LIR and RRL.

(b) 'Switching' task

In Experiment 2 this task had been presented using screens. This was found to be inconvenient in presentation. It was therefore decided to return to the more standard presentation used in Experiment 1, and to use cups rather than screens.

In Experiment 1 the cups had always been used inverted to conceal the object. It was observed that attention to the task was sometimes enhanced when the cups were kept upright (but with the object still non-visible). The 'switching' task with cups upright was therefore occasionally included in the set of tasks, in addition to the standard presentation with cups inverted. Presentation for both tasks: RLRL / LRLR.

(c) 'Deduction' task

The standard Piagetian 'deduction' task was retained. It was noted above (p.60) that certain components of the task seemed to be critical in determining the degree of difficulty of the task. It appeared possible for infants to locate the object (following its displacement by means of the cup, and its deposition behind a screen) without making use of 'deduction' from the emptiness of the cup. Search of the empty cup - either visual or manual - must, clearly, be observed in order that correct retrieval could be attributed to 'deductive' processes. In view of the importance of this inference for a test of Piaget's Stage VI, careful attention was given to this feature. Presentation: Object deposited LRLR/RLRL.

A second task concerned with deductive processes had been included in Experiment 2. This task focused on the phenomenon of 'capture by contact' as a possibility envisaged by the infant (see p.54). However, as noted above (p.63), presentation of this task to normal infants did not yield a clear pattern of achievement over age. Indeed, no subject registered a pass on both trials of the task. It was considered, therefore, that results on this task could not be expected to be sufficiently clear-cut for meaningful

population differences to emerge by its employment. However, it was felt that certain aspects of the task might be incorporated in a new task which related more closely to the other items employed. In the earlier task subjects were presented with a situation in which, in their eyes, an object may, or may not have been picked up by a moving vessel during the latter's trajectory. This feature of uncertainty appeared to have encouraged subjects to continue searching for the object beyond a first location. Corresponding uncertainty was therefore introduced into a task directly concerned with such secondary search (i.e. with 'deduction'). The new task consisted of two steps. First the object was concealed behind one of two screens. An inverted cup was brought across behind the screen. It captured the object and was brought to rest in front of the infant, who was required to retrieve the object (either directly or after first searching behind the first screen). Second, the same step was repeated with the other screen except that the object was not captured. The infant was required to search in the cup and then retrieve the object. It should be noted that, in this task, concealment of the object (in its final location) is performed visibly. The critical element for 'deduction' tasks - search initiated by an absent object - is retained.

Presentation: Object first concealed at RLLR/LRRL.

3.3 Administration

As noted above (p. 44) preliminary work with DS infants had made it clear that flexibility in presentation would be unavoidable. The findings of Experiment 2 (p. 57) suggested that varying the order of presentation of tasks should not lead to artefactual variation in results. It was felt to be justified to vary presentation order in response to the subject's attention and orientation to the task situation as a whole.

4. Results

As will be noted during this section - and as has been noted above - several features of the administration and of results were felt to necessitate comparative information with normal infants. This comparison study is described below (Chapter VI). Since many of the results can only be evaluated in comparative terms, consideration will be given to them at that point. Here, some of the more striking results will be noted, and some consideration will be given to their implications.

First it should be noted that the general behaviour characteristics observed in the preliminary work were also encountered in this longitudinal study. As before, these characteristics (see p. 43) - such as lapses of attention, or failure to orient to the task - are difficult to quantify. They are, however, sufficiently striking in the experimental context for recognition of them to be necessary.

The most generally reported index of development is the age of first achievement. The mean chronological age at which subjects first registered criterial success on the tasks is presented in Table 5. Prior to the presentation of more precise comparative data (Chapter VI) these values are compared to approximate norms derived from the literature (Piaget 1955; Bower 1974a).

TABLE 5 Mean Age of First Achievement for DS infants (Experiment 3)

Task (see text p. 80)	Level of success	Mean Age of First Achievement (months)	N	'Norm' from literature (months)
a	RRL & LLR	21.0	7	10 - 12
b	RL	23.25	6	14 - 18
	RIRL	28.7	5	14 - 18
c (i)	RL	29.75	2	14 - 18
c (ii)	RL	27.0	4	Not available

Further analysis of the response patterns was carried out. It was noted that initial success on a certain task was not followed by consistent repetition of that success in subsequent sessions (see Table 6). Such inconsistency could be expressed by the proportion of sessions following that containing initial success in which success was repeated. Over all tasks and subjects, the average 'retest reliability' or 'repeatability' was found to be 50.6%. Thus, having demonstrated success on a task, there was just over a 50% chance of the subject demonstrating it again in a subsequent session. More detailed results on this feature will be presented below (Chapter VI).

TABLE 6 Results of Longitudinal Testing of DS Infants on Three Tasks
(Experiment 3)

Subject No	Task	Session											
		1	2	3	4	5	6	7	8	9	10	11	12
1	1	-	-	-	-	+	-						
	2	-	-	-	-	-	-						
	3	-	-	+	-	-	-						
2	1	-	+	+									
	2	-	-	-									
	3	-	+	+									
3	1	-	-	-	-	-	-	-	-	-			
	2	-	+	+	+	+	-	-	-	+			
	3	-	-	-	-	-	-	-	-	-			
4	1	+	-	+	+	-							
	2	-	-	-	+	+							
	3	-	-	-	-	-							
5	1	+	+	-	-	-	+	+	+	-			
	2	-	-	-	-	+	-	+	+	+			
	3	-	-	-	-	+	-	+	+	-			
6	1	-	-	+	-	+	-	-	-	+	-	+	-
	2	-	-	-	-	+	+	-	+	-	-	+	+
	3	-	-	-	-	-	+	-	-	-	-	-	-
7	1	-	-	-	+	+	+	+	+	+			
	2	-	-	-	-	-	-	+	+	+			
	3	-	-	-	-	-	+	+	+	+			
8	1	+	-	-	-	-	+	-	+	+	-	-	
	2	-	-	-	+	0	-	+	-	+	+	+	
	3	-	-	-	-	-	-	-	+	+	-	+	

Tasks: 1 'AAB' task
2 'Switching' task (cups inverted)
3 Second 'deduction' task

For all of these, see text, (p. 80)

Key: + : pass
- : fail
0 : not administered

5. Discussion

By comparison with normal expectations, the DS infants present a clear picture of delayed achievement. This finding is in keeping with the theoretical accounts of 'slow development' currently available. As was emphasised above, however, this result cannot be seen as an adequate validation of the stronger forms of the available accounts. The concept of 'slow development' entails considerably more than the observation of delayed achievement. This first general result must be seen as a necessary, but by no means a sufficient condition for the 'slow development' theory. It has no bearing on the more specific predictions of that theory, and it does not illuminate the question of differences between the development of the DS and the normal child.

The calculation of 'retest reliability' is a preliminary step in the more detailed investigation of the developmental pattern. Conclusions are commonly drawn from the observation of ages of achievement. Such conclusions make assumptions about the representative nature of these specific achievements. If it is the case that subjects will consistently reproduce successes in subsequent sessions - that is, that 'competence' must be either absent or present, and if present must be manifested - then the results of any single assessment would accurately represent the subject's ability. Reduction of the data into the terms of first achievement would not distort the results. The results would be 'reproducible' in a manner analogous to the rationale of Scalogram Analysis (see p. 46).

It can be seen, therefore, that the extrapolation of results in terms of specific achievements to yield an evaluation of development as a whole

requires that these achievements are indeed representative. If, however, this requirement is not fulfilled, the extrapolation is not justified. The slowness of emergence of specific skills cannot be taken ipso facto to explain the whole developmental pattern. At the least, extra theoretical consideration would have to be made, to explain the poor reproducibility of success. Explanation would probably take the form of a 'difference' argument. The 'slow development' theory would, therefore, be shown not to be adequate.

The obtained value for reliability would seem, intuitively, to present a serious challenge to the assumption that 'developmental levels' may be equated, across subjects, on the basis of achievement alone. Before any firm conclusions can be reached on this point, however, it is clearly essential to obtain comparative information for the normal subject. If, for whatever reason, the reliability for the normal infant were found to be no higher than that for the DS infant, implications specific to the DS population would not be justified. Comparative study was indicated for more positive reasons, too. If differences in performance between the two populations were to be investigated, information on the normal infant would be required at a more finely detailed level than that of 'norms'. Precise data on the nature and distribution of errors would be required. Meaningful comparison could then be made between the two populations.

This comparative study, and the analysis of such population differences, is presented below (Chapter VI). Before carrying out this study, however, it was felt that some clarification of the

characteristics of the DS population might be made by a brief assessment of children at pre-school age. Analysis of the infant sample (aged up to $2\frac{1}{2}$ years by completion of the study) had shown that successful performance over sessions was extremely inconsistent. Such a characteristic of performance could be interpreted in two distinct ways. It might be seen as a permanent state, and thus it would be predicted that performance for these tasks would always exhibit similar inconsistency. This interpretation would be in line with a 'deficit' approach to mental handicap (see p. 36). Alternatively, it might be argued that inconsistency per se was indeed a permanent characteristic, but that the tasks on which it would be manifested would vary with CA. Thus any given set of tasks - e.g. those concerned with sensorimotor intelligence - would eventually become 'consolidated' and consistently successful performance would be exhibited. (At such a point, it might be predicted, tasks more appropriate to CA might well manifest similarly low levels of consistency as did the sensorimotor tasks for infants). This interpretation would exemplify the 'developmental difference' approach outlined in the Introduction (p. 36).

To obtain some evidence on this issue, it was decided to carry out a small study of DS children at the pre-school age before commencing the comparative study with normal infants.

CHAPTER V : STUDY OF PRE-SCHOOL AGE DS CHILDREN

(Experiment 4)

1. Introduction

As reported in Chapter IV it was found that DS infants of up to $2\frac{1}{2}$ years of age could not be relied upon to demonstrate clear success on the range of tasks presented. It was therefore of interest to establish whether this state of affairs should be seen as an enduring aspect of behaviour, or whether it was a state which would be transcended during later development. If it were the case that DS children's performance on these tasks always presented the same picture, then explanation might be sought in terms of a general behavioural deficit. In this case, nothing specific would have been said about the cognitive development of the DS infant. It could even, then, be argued that cognitive development per se is indeed 'slow', and that, in addition, its realisation in performance is mediated by defective production processes.

If, on the other hand, it could be shown that by the pre-school age of 4 - 5 years the DS child can perform adequately on these tasks, then the lack of reliability in the younger subjects would have to be seen as a developmental phenomenon, and as a central aspect of the cognitive development of the DS infant. Since it is with the achievements of infancy that this thesis is concerned, it was decided not to attempt an evaluation of the prediction above (p.88), concerning performance on tasks transcending sensorimotor intelligence.

2. Subjects

Parents of DS children in the Edinburgh area were approached as described above (p. 55). Four children (two boys, 2 girls) aged from $3\frac{1}{2}$ - 5 years acted as subjects. Except for one subject, who had taken part in the single session of Experiment 1 (12 months previously), all were naive subjects.

3. Procedure

Apparatus and materials were as described above (p.39).

Subjects visited the laboratory twice, with a week's gap in between visits. Tasks presented consisted of those used during the longitudinal study. These consisted of the 'AAB' task, the 'switching' task with cups inverted, and both forms of the 'deduction' task (see pp. 80-82).

4. Results

Results are presented in Table 7. As can be seen, nearly perfect success patterns were obtained. It was noted in presenting tasks that attentiveness on the part of the subjects seemed to be generally higher than with the younger infants in the longitudinal study.

TABLE 7 Results for Pre-School Age DS Children (Experiment 4)

Task and Criterion of success (see text)	session 1				session 2			
	s1	s2	s3	s4	s1	s2	s3	s4
'AAB' task RRL/LLR	+	+	+	+	+	+	+	0
'Switching' with cups inverted RL	-	+	+	+	+	+	+	+
'Deduction' /1 RL	+	+	+	+	0	+	+	-
'Deduction' /2 R/L	+	+	+	+	+	+	+	+

Key: + : pass - : fail 0 : not administered

It is possible to compare present results with those obtained by the younger infants in the longitudinal study. Comparison may be made with respect to performance on the next session following success. From Table 6 (p.85) it can be seen that, for the younger infants, out of a total of 19 cases of first achievement success on the following session was obtained in only 10 cases. As Table 7 shows, repeated testing was carried out for 13 cases of initial success with the older group. Statistical comparison of these results may be carried out by means of Fisher's Exact Probability test. Exact probability for the obtained distribution of next-session success is found to be $p=0.0201$. It can therefore be concluded that the older DS infants are superior to the younger with respect to the reproduction of successful achievement.

5. Discussion

In general, then, it can be said that DS children can be expected to perform successfully and fairly consistently on these tasks by the pre-school age of 4 - 5 years. Reliability contrasts markedly with that in infancy. The change in this parameter implies that the level of consistency of success must be seen as an integral part of the cognitive development of the DS infant and child. In addition to the gradual achievement of specific criterial successes, the infant is increasing the consistency and reliability with which such successes can be repeated. They are thus increasingly becoming part of a 'repertoire'. This latter developmental change must be taken into account in formulating explanatory models.

The present finding might perhaps be interpreted as a dissolution of the differences identified in the period of infancy. It could be therefore argued that at this point in development there is indeed a real equivalence between the (pre-school age) DS child and the normal infant. Such equivalence relations are fundamental to the 'slow development' theory (as well as to the general psychometric account of development). Such a claim would have a certain formal validity. However, it is strictly limited to a single comparison: to an equivalence between two populations at fixed CA. It does not have a developmental dimension. It would entail that equivalence does not exist prior to the DS child's attainment of age 4 - 5 years.

The parameter of the reliability of success has been taken as an indication of developmental change in the DS child more general than the accretion of specific cognitive skills. However it is clearly, still, a gross measure. It leaves open the question of what kind of

response is made when a former success is not repeated. The Piagetian form of the 'slow development' theory postulates that such failures will take the form of 'rational' errors, characteristic of certain general, structural features of cognitive 'stage'. Such issues can only be studied in a comparative fashion, as reported in the following chapter.

The short study reported here illustrates the importance of looking beyond 'milestones' of development, even within a population. It therefore seems to point to the importance of such a practice when investigating differences between populations. In this respect, as well as adding to the descriptive picture of the course of development in the DS child, it has strengthened the tentative interpretations drawn from the longitudinal study, and made imperative the acquisition of comparative data on these issues.

CHAPTER VI : COMPARATIVE LONGITUDINAL STUDY WITH NORMAL INFANTS

(Experiment 5)

1. Introduction

Chapter IV reported the longitudinal study with DS infants. The results which emerged from that study showed that, in addition to the delayed achievement of criterial responses, there seemed to be more general aspects of the infants' performance on which differences from normal expectation occurred. In particular, it was noted that the 'reliability' of task successes (over sessions) was just over $\frac{1}{2}$. The small study of slightly older DS children, reported in Chapter V, suggested that this feature was not a global and determinate aspect of the child's behaviour, but that it was subject to developmental change. The identification of this effect was not seen as the end of enquiry, but rather as an illustration that the course of cognitive development in the DS infant may well be different in nature to that of the normal infant.

Before proceeding with an investigation of such differences in greater detail, it was clearly necessary to establish whether the apparent difference in reliability was a real one. It was possible that, rather than being a true population difference, it was caused by the methodological procedure of varied order of presentation. Since the reliability parameter is, by definition, appropriate only to repeated measures, the conclusions of Experiment 2 (p. 57) that the procedure does not influence results in a single session cannot be adequate to discount this possibility.

The first major aim of this study was, therefore, to establish the reliability over the set of tasks for normal infants. It was

hoped that further analysis of the responses to the tasks could then be made, to make possible a precise comparison with those of the DS infants.

For both practical and financial reasons, it was not feasible to study a sample of normal infants over the same time-span as had been done with the DS infants. In this connection it should be emphasised that the present study should not be seen as a strict 'control' group for the DS sample. The methodological problems in matching subjects from the two populations are extensive (see Clarke & Clarke 1975). Instead the study should be seen as an attempt to obtain comparative information on certain specific aspects of cognitive development.

With respect to the question of reliability, it was considered that a series of four sessions, at 2 - 3 week intervals, should provide an adequate set of comparative data.

2. Subjects

Subjects were obtained from a pool of normal infants (see p. 55) whose parents had expressed willingness for them to participate in research studies. Twenty-six infants were selected (14 boys, 12 girls). Two infants represented each month of age from 9 - 21 months inclusive at the start of the study. There were thus 13 pairs of infants, the members of a pair being the same age.

3. Procedure

3.1 Sessions

Subjects were scheduled to attend four sessions each, at two-weekly intervals (but 3 weeks when a holiday period intervened). One subject-session only was lost (due to hospitalisation).

3.2 Tasks

Choice of tasks was constrained by three factors. First there was a need to establish certain general parameters of longitudinal performance over a comparable range of tasks for the normal as for the DS infants. Second, more specific information was needed on certain tasks. Third, however, was the limitation that tasks must all be administered readily within a single session (of 15 - 20 mins.)

As with the longitudinal study with DS infants, tasks fell into three groups.

(a) 'AAB' tasks

It has been suggested (Gratch et al. 1974) that a critical feature of the presentation of this type of task is the time-lag between presentation of the 'catch' trial and the onset of the infant's response. The authors found that if a pause of 1 second or more were imposed on the infant, the task proved more difficult than in the absence of such a pause. In carrying out the study with DS infants, it had not always been possible precisely to control this feature. Restraint of the infant frequently led to total inhibition of response. It was therefore decided to obtain comparative information on this point, by administering the task both with and without imposing such an additional pause (in

addition, that is, to ensuring that the object had been concealed and the experimenter's hand removed prior to the infant's response).

These two variations therefore made up Tasks 1 and 2. Each was presented twice: LLR & RRL.

(b) 'Switching' tasks

As noted above (p. 81), it had been found that DS infants could on occasion be more readily interested in the transposition task if the cups were used upright rather than inverted. It was therefore necessary to obtain information on the relation between these tasks for the normal infant. These two tasks made up Tasks 3 and 4. For each, transposition was carried out 4 times: RLRL/LRLR.

(c) 'Deduction' tasks

The two 'deduction' tasks presented to DS infants (p.81) formed Tasks 5 and 6. Careful attention was given to the requirement that the infant make a clear search (visual or manual) of the empty cup prior to 'deductive' response. Task 5 (the standard task, derived from Piaget) was presented 4 times, with the object being displaced to each side twice (thus RLRL/LRLR). Task 6 was presented twice, with the 'catch' trial occurring with the object concealed on each of the sides, thus: RLRL/LRLR.

3.3 Balancing

There were 6 tasks, each to be presented to each infant at each of four sessions. A Latin-square design was obtained from the study of

Kramer et al (1975) which, similarly, presented six tasks in a controlled set of orders. The Latin-square presents 6 different orders for the six tasks, in which each task precedes each other task once, and each task follows each other task once, in the six different sequences. Immediate carry-over effects are therefore balanced out.

The 2 infants from each pair received between them, over the four sessions, each of the orders A - F at least once and not more than twice. Over all subjects and sessions, each different order A - F was used at least 16, but not more than 18 times. Presentation order was thus balanced both overall, and within pairs (since carry-over effects might differ between pairs).

The initial starting side for the first trial on a task was selected at random.

4. Results and Discussion

4.1 General Results

4.1.1 Results for the Normal Infants

Table 8 presents findings on the mean ages of first achievement for the various tasks. In some cases, ages are given for two different levels of success in the same task.

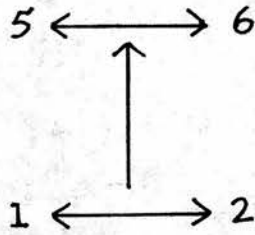
TABLE 8 Mean Age of First Achievement (months) for the Normal Infants
(Experiment 5)

Task (see text p.96)	Criterion of success	Mean age of first achievement (months)
1	RRL & LLR	12.0
2	RRL & LLR	12.3
3	RL RRL	16.2 18.1
4	RL RRL	16.4 17.4
5	RL RRL	18.3 18.5
6	R/L RL	16.3 17.8

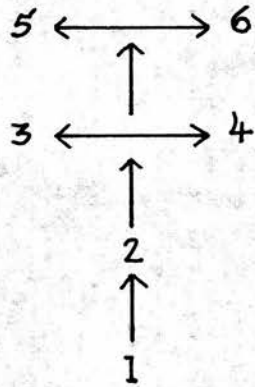
R,L denotes side object initially concealed

Results of Ordering Theory analysis (see p.48) is presented in Figure 2. Two 'trees' are given, owing to the nature of the present design. The analysis is designed for a cross-sectional design in which each subject is tested once. In the analysis of a (semi) longitudinal design, it is necessary to make one of two assumptions regarding the data. It may either be assumed that the results of repeated testing can be pooled, as if different subjects had participated in each session, or that success on an item in a previous session may be counted in the comparison with another item in a later session. Results for both procedures are presented (as 'a' and 'b' respectively). It can be seen that the first procedure, which treats each session as involving a new sample, gives rise to few significant relationships (and none involving Tasks 3 or 4). The second procedure,

FIGURE 2 Results of Ordering Theory Analysis of Performance by Normal Infants (Experiment 5)



(a) Where results are pooled across sessions (see text)



(b) Where subject's success in previous sessions is taken into account (see text)

Key: I \longleftrightarrow J I 'prerequisite' for J (at 5% level of significance)

I \longleftrightarrow J I 'equivalent' to J (difference N.S. at 5% level)

Note: Where a task fails to appear in a tree, it cannot be located in any "prerequisite" relations

which takes account of the repeated measures aspect of the design, expands on this picture while retaining its significant features. It should be noted that, with this enriched procedure, the results are generally in agreement with previous assumptions. There is a linear relationship between the three kinds of task, and, with the exception of the first two, both tasks of a pair (i.e. 3 and 4, and 5 and 6) can be seen as equivalent. Some implications of these findings will be introduced below, in discussing specific tasks.

4.1.2 Delay and 'Rate' of Emergence

In Table 9, extracts from Tables 5 (following p. 83) and 8 are combined to enable comparison between the DS and the normal infants to be made. In addition, results for the DS infants on Task 2 is included in Table 9. As can be seen, mean emergence is earlier for the normal infants, across all tasks. The Mann-Whitney 'U' test was carried out to determine whether the results from the two populations were significantly distinct (and not overlapping with respect to chronological age). As can be seen, differences were all significant ($p < .05$). The DS infants were, therefore, clearly later in achieving these successes, as a population, than the normal infants.

TABLE 9 Comparative Results for DS and Normal Infants
(derived from Tables 5 and 8)

Task	Criterion of success	Mean age of first achievement (mo.)		Delay of DS infants (mo.)	Significance level of population difference *	
		DS	N		prob.	U=
1	RRL & LLR	21.0	12.0	9.0	p < .05	1
2	RRL&LLR	22.8	12.3	9.5	p < .05	2
4	RL	23.3	16.4	6.9	p < .05	2
5	RL	29.8	18.3	11.5	p < .05	0
6	RL	27.0	17.8	9.2	p < .05	3½

For the task order 1, 2, 4, 6, 5 order of emergence is identical across the two populations (see text, p.102)

* Mann-Whitney U test

Correlation for the order of emergence of achievements across the two populations was obtained using Kendall's tau. Order of emergence was highly correlated ($\tau = 0.81, N = 7, p < .05$).

The concept of 'rate' with respect to development has generally been employed in the context of psychometric assessment, where a quantified score is available for comparison across age. In the present context, it is possible to compare the delay of first emergence (on behalf of the DS infant) on a set of achievements. For a set of tasks on which order of emergence is identical across the two populations, it might be suggested that the sequence of delays exhibited by the DS infant might show a regular trend.

As noted above, order of emergence was highly correlated between the two populations. A set of five tasks for which order of emergence

was identical is presented in Table 9. The linear regression line for this set of results has a slope of +0.25. Thus, on assumption of a linear trend, it would be suggested that a relative increase in delay was occurring with age in the DS infants. However, the assumption of linearity cannot be justified. The product-moment correlation between size of delay and chronological age ($r=0.66$) does not differ significantly from zero ($t=1.52, df=3$). A simple relationship between size of delay and age cannot be assumed. The linear regression cannot be taken as an adequate representation of the data, and no straightforward pattern of change in the series of delays can legitimately be asserted.

4.1.3 Overall Repeatability of Successes

For DS infants the overall probability of reproducing success was found to be equal to 50.6% ($p=.84$). For the normal infants in the present study, this value was found to equal 71.9%. In order to compare performance by the two groups, results for the DS infants were re-analysed to obtain reliability over the next three sessions only following initial success. This value was found to equal 56.25%. Comparison of this value with that obtained for the normal infants yields $t=2.04, p<.05$ ('t' test for proportions; Guildford 1956). With respect to the reproduction of success on subsequent sessions, then, significant superiority was demonstrated for the normal infant over the DS infant.

4.1.4 Brief Discussion

The emergence of specific achievements was delayed to a statistically significant extent in the DS population. Order of emergence for different tasks was, in general, the same for the DS and the normal

infants. No clear pattern was observed in the degree of delay across time. These findings are in accordance with the previous literature and, to the same extent, offer support to the 'slow development' theory.

However, once having achieved a certain criterial performance on a task, patterns of subsequent performance differ between the two populations. DS infants are less likely to repeat a success, given the opportunity to do so, than are normal infants. This difference does not appear to be due to a simple 'deficit' on the part of the DS infants, since the difference disappears when slightly older DS children are tested (p.91). Thus it must be seen as an integral part of the pattern of cognitive development in the DS child.

It is not, therefore, possible to set up equivalence mappings between the DS and the normal population on the basis of first achievement alone. This parameter is not equivalent in the two populations. The term 'slowness' is clearly accurate as a description of patterns of emergence. It is not, however, adequate as an explanation.

It must be stressed that the index of 'repeatability' is itself a gross measure. The observation of differences in its value between the two populations - a difference of degree rather than of kind - must be seen as calling for explanation. It must be determined in what manner the DS infants are failing to reproduce success. This information must be related to their overall pattern of response. If the phenomenon of slow emergence should be interpreted as merely one aspect of the development of the DS infant, a similar status must be assigned to the low repeatability of success. At the very least,

investigation of the patterns of error in different tasks must be carried out. A methodology of analysis which limits itself to dichotomising performance into success or failure is clearly not adequate. The next section will therefore analyse response patterns to specific tasks in greater detail.

4.2 Comparative Analysis of Specific Tasks

As noted above (p.96) the tasks administered in this investigation fall into three broad categories. Results and discussion of comparisons between the two populations - and, where relevant, of characteristics of the normal population alone - will be presented with respect to these categories.

4.2.1 'AAB' Tasks

Analysis considered the nature of errors being made. In these tasks, an error consists in an initial search at the location previously occupied by the object (in earlier trials). It was observed that such initial response was sometimes followed immediately by search at the correct location. This second response frequently appeared more as a continuation of the first, than as a distinct and new one. Errors could therefore be differentiated according to this criterion. It might be suggested that (whatever the 'meaning' of the response) such correction reduces the strong diagnostic value of the initial error. For these reasons, the non-corrected, and corrected forms of the error are here referred to as 'real' and 'operational' errors, respectively.

For the purposes of analysis, error responses for both tasks were pooled. The distribution of error types was uniform across the two tasks. The relative occurrence of 'real' errors in the DS and normal infants was 57% and 60% respectively. This difference is not statistically significant ('t' test for proportions: $t = 0.23$, NS). However, the distribution of types of error across age is different between the two populations. For the normal population, there is a clear separation between the 'real' error as characteristic of the younger infant, and the 'operational' error as characteristic of the older infant. This separation is statistically significant (Mann-Whitney 'U' test: $U = 15.5$, $p < .05$). It should be noted that the age of the 'older' infant here (above 14 - 15 months) is well above the mean age of achievement of the task (12 months).

This difference clearly vindicates the procedure of making a distinction between the two kinds of error. (It should be noted that the cross-sectional design makes it impossible to account for the age trend simply in terms of individual learning across sessions). Further, the direction of the trend adds weight to the theoretical interpretation of the difference. Whatever causes the initial error in the normal older infant (when it occurs), its immediate correction indicates that it cannot be attributed the same representative function as in the younger infant. Thus the error cannot unambiguously be interpreted in terms of one specific cognitive structure.

The distribution of the two kinds of error is uniform for the DS infants. An error occurring at any time has a probability of 43% of being an 'operational' one. Diagnosis of cognitive structure -

the use of such errors to assign an infant to a 'stage' of development - cannot be a reliable procedure. The failure to reproduce a previous success, in a given session, cannot be assumed to necessitate the committal of a 'characteristic error' on the task. For the normal infant, errors committed earlier than the mean age of first success at the task could confidently be assumed to be 'real' errors. This assumption cannot be made with the DS infants. Thus first achievement cannot be assigned the same representative function in the DS as in the normal infant. In the DS infant it cannot be seen as a firm achievement, arising subsequent to coherent and 'rational' error. Any theory which posits equivalence between the two populations in terms of first achievement cannot be adequate. Further, it should be stressed that the status of the DS infant prior to first achievement cannot be equated with that of the normal infant in a formally similar state. The DS infant may exhibit certain responses apparently diagnostic of a greater 'sophistication' than his formal peer (namely the 'operational' error). The whole pattern of response and the status of those elements defined as 'success' must be seen as different from that of the normal. Therefore the status of any single parameter must also differ.

4.2.2 'Switching' Tasks

Results are presented in Table 8 (p.99), for these two tasks (Nos. 3 and 4) for the normal subjects. The mean ages of first achievement are presented for two levels of success in the tasks (see below). The small differences between age of achievement for the two tasks (at equivalent levels of success) support the finding of Ordering

Analysis (Figure 2, p.100) that the two tasks are of equivalent difficulty for the normal infant. It was noted above (p. 81) that the version of the task with cups upright was occasionally administered to the DS infants. Sufficient data is not available however to enable complete comparison to be made on this version of the task. In view of the differences emerging between the response patterns of the two populations to identical tasks (4.2.1 above), it was not felt justified to infer equivalence for the two tasks with respect to the DS infants. In what follows, therefore, comparison will be made on the basis of results with the standard version of the task only (Task 4, with cups inverted).

It may be noted from Table 5 (p. 84) that for the DS infants, a difference of some 5 months appears between the mean age of attainment for two levels of success in Task 4. This difference is statistically significant (Mann-Whitney 'U' test: $U = 4\frac{1}{2}$, $p < .05$). No such lag occurs for the normal infants (Table 8, p. 99) for whom the difference in means is one month ($U = 49$, NS). This finding emphasises the problem of 'representativeness' in the study of the DS infant (see p. 86). For the normal population, achievement occurs in a saltatory fashion and success at either level could be taken as representative of attainment. This is not the case for the DS infants, at least for this specific task. If there is a noticeable lag between the achievements of lower and higher levels of a task, then neither point can be interpreted unambiguously. The earlier point, if taken as an index of 'achievement' would apparently overestimate current ability. The latter point would underestimate the infant's status prior to achievement. It appears that certain assumptions about the

general nature of response patterns which might be justified with the normal population cannot be utilized in assessing the cognitive status of the DS infant.

As with the tasks considered above, an analysis of error patterns on the 'switching' tasks reveals differences between the DS and the normal population. The 'characteristic' error on these tasks - i.e. the response pattern with equivalent diagnostic value to success - consists in the infant's consistent search for the object at the location where it was seen to be hidden. This strategy is always incorrect, since transposition of the occluders transfers the object to the other side. In a simpler task (such as the 'AAB' task), where no transposition takes place, this strategy would be the correct one. It becomes erroneous when applied to the more difficult task. Since task difficulty is held to reflect developmental changes in competence, such a 'characteristic error' is diagnostic of a lower 'level' than that defined by success on the task.

Analysis of error patterns in the normal infants shows that this 'characteristic error' strategy represents 46.9% of failures on the task. For the DS infants, this value is 25.8%. This difference is significant ('t' test for proportions: $t = 2.23$, $p < .05$). Thus failures on this task are much less likely, with the DS infant, to take the form of the strategy appropriate to the 'cognitive level' below that defined by success on the task. A failure to pass cannot be interpreted as diagnostic of the 'next lowest' level below that of a pass. Clearly, the informational value of the test - in presenting a binary 'choice' between two levels or stages - does not hold up for the DS infant.

It should be stressed that occurrences of the error patterns under investigation overlap with occurrences of success. Thus the successes must be seen against such a background - rather than as emerging from a former state of consistent and 'developmental' error. As before, the relationship between specific achievements and the general patterns of response to that task do not appear to be the same for the DS as for the normal population. Hence it would not seem legitimate to isolate such successes from their general context in order to set up mappings of equivalence between the two populations.

4.2.3 'Deduction' Tasks

As with the other tasks presented to both populations, an analysis of error patterns was carried out. For both these tasks, the 'characteristic' error consists in the infant's failure to search for the object, having noted its absence where previously seen (inside the cup) (see Bower 1974a, p.187). This response is consistent with the theoretical interpretation that infants have no understanding of the behaviour of the object, beyond an expectation for it to re-appear where previously seen. The infant should have no strategy of search available.

Analysis of errors was made over both tasks. The 'characteristic error' predominated for the normal infants. Frequently the absence of any search of occluders was accompanied by the infant's looking around to his side, or below the table. This behaviour was interpreted as an undifferentiated, 'global' search, but entirely consistent with the 'characteristic error'. For the DS infant, however, errors were more

likely to consist of search of (incorrect) occluders, following the initial search of the empty cup. Comparison was made of the occurrence of such 'errors of commission'. The frequency of such error for the normal and DS infants had values of 32.1% and 53.3%, respectively. This difference is significant ('t' test for proportions: $t = 2.09$, $p < .05$). Thus, in general, a failure on behalf of the DS infant was less likely to consist in the 'characteristic error' of lower stages of development, than was the case with the normal infant. Indeed, it could be argued that the 'error of commission' in these tasks is indicative of higher levels of 'cognitive structure' than is the 'characteristic error'. The infant would appear to be demonstrating some operational understanding of the possibilities for non-observed behaviour in the object. If this is the case, then the methodological procedure of equating lack of success with a specific kind of error would seem particularly mistaken in this case. Certainly the general pattern of response - from which successes emerge in these tasks - would appear to differ between the two populations. It is unlikely that processes postulated for the developmental changes in the normal infant would be applicable, without at least some alteration, to the case of the DS infant.

As with the other kinds of task discussed above, then, the diagnostic value of single results on a task seem to be severely limited for the DS population. Success on a task does not emerge from an equivalent 'lower' state as in the normal population, and initial achievement does not represent transition to a new state in which success is consistent. As before, the interpretation which can be placed on success or failure is not homogeneous across the two populations. Any

procedure which assumes such homogeneity cannot, therefore, be legitimate.

5. General Discussion

5.1 Theoretical Background

The theoretical positions under consideration should be restated before discussing the significance of the present results. The strong form of the 'slow development' theory states that the behaviour of the DS infant at a certain age can always be described in terms of equivalence with that of a younger, normal infant. The developmental pattern is seen as a linear series of such equivalence mappings. Thus, simultaneously, models of both the normal and the atypical developmental patterns are being set up. The model for normal development consists of a sequence of specific behavioural achievements, which are attained in a fixed order. Empirically determined age norms for these achievements are incorporated into the theory. The model for the mentally handicapped infant is a transform of the 'normal' model, such that some (significant) delay is introduced for each achievement. Thus the normal model is transformed by a linear expansion over chronological age.

It was argued above (p. 24) that such a model, as it stands, has no explanatory power (either for the normal or the atypical case). Such power can only be achieved by incorporating within the theory a more sophisticated model of normal development - while retaining the procedure for deriving the secondary model of atypical development. If the model of normal development is filled out to include the behaviour associated with lack of success at specific tasks, then the

possibility emerges for explanations of the changes associated with age. The account is not limited to describing the emergence of certain achievements at certain times. The derived model for the DS infant is, in a corresponding fashion, rendered more complete. The equivalence mappings which are set up between the two populations are specified in terms of specific patterns of response. Such an 'enriched' version of the theory is of value for several reasons. It permits testing, since it makes predictions which go beyond the data from which it was formulated. If substantiated, it would present a complete and cohesive model for the development of the DS infant, and one from which clear implications for manipulative intervention, for example, could be drawn. If shown to be untenable it would demonstrate the very limited use of the 'slow development' terminology. Further, it would bring to light deviations from equivalence, which would thus constitute differences in development between the two populations. Such differences would stand in need of explanation, which, if adequately accomplished, would considerably further understanding of the handicap.

The late emergence of 'milestones' in development is a general empirical finding for the DS infant (e.g. Carr 1975). It should be noted that some of the tasks utilised in the present study bear some resemblance to certain items employed within psychometric assessment. For example, tasks concerning 'unwrapping' objects and otherwise retrieving them from occlusion can be found in the instruments of Bayley (1969) and Gesell (Gesell & Amatruda 1947). Such similarity in tasks might be expected to give rise to some similarity in findings, at a first level of analysis. At such a level - that of first emergence - this expectation is confirmed. For the reasons given above, however,

this finding offers no additional support to the theory of 'slow development'. It is in analysis at greater depth that the information is to be sought which will enable an evaluation of the theory to be made.

5.2 Theoretical Significance of Present Findings

In keeping with general findings on longitudinal assessment, it was found that the emergence of success on the tasks presented was always delayed in the DS infant, relative to the normal infant. The order in which such emergence occurred was generally identical between the two populations. Thus the kind of result on which current theory has been constructed is extended from the kinds of achievement assessed in the psychometric tradition, to the more finely specified area of cognitive development in the infant. As a description of the chronological course of initial, criterial achievement, the term 'slow' is clearly legitimate.

Closer analysis revealed, however, that the nature of both achievement and of failure seemed to be different between the two populations. In general, normal infants will repeat success in subsequent sessions; the initial achievement can, therefore, be taken to represent a solid 'competence' for the task. The infant can be seen as moving from a state of not-being-able to perform the task, to a state of being-able to perform it. This kind of saltatory change is the empirical basis for 'stage' theories of development (although such theories, of course, have significant theoretical origins too). The DS infant demonstrates a much lower 'repeatability' of success. In this respect, such successes - whether initial, or subsequent - cannot

be given the unambiguous interpretation that is justified in the normal case. If the initial achievement is credited as an indication of 'competence' then it is difficult to explain subsequent failure. An achievement that 'comes and goes' cannot be equated with one that appears to represent a change of state at a 'high level' (see below, 5.3 for an expansion of this interpretation).

The state from which successes emerge - and to which response frequently returns - is not the same across the two populations. In general, the nature of error patterns in normal infants is consistent with a developmentally prior state of cognitive structure. Such error patterns can be used to make diagnosis of cognitive process, together with which the changes associated with subsequent achievements may be seen as coherent. Thus the state from which the (relatively permanent) achievements emerge may be seen as consistent with a general, high-level description of cognitive structure at that time. The theoretical accounts of normal development make equal use (and give equal diagnostic weight) to characteristic successes and to characteristic errors (Piaget 1955; Bower 1974a). For the DS infant, in contrast, the nature of error cannot be predicted on the basis of a status expressed in terms of achievements. Differences occur in diverse ways. The pattern of error may not consistently manifest the active strategy of search which, it is argued, should result from the infant's previous achievement. Thus the interpretation of this previous achievement is called into question. Alternatively, active search may be exhibited when total inhibition of search is predicted. In this case, the subsequent achievement of this task -

in which search is immediately correct - might seem to be less of an advance than if it emerges 'complete', as the first kind of search strategy for the task. Finally, even when the occurrence of a characteristic error is comparable in the two populations, there may be differences within the finer structure of the error. If immediate correction of an error can be seen as an indication of developmental advance (and analysis of the normal infant would suggest that it can) then the recording of an error without further analysis may well lead to under-evaluation of the DS infant.

Both in terms of successes and failures, then - that is, across response patterns as a whole - differences emerge between the DS and the normal infant. Only at the most superficial level of analysis - that of emergence of initial success - can isomorphism be found between the two populations. Clearly, the 'slow development' theory fails to predict such differences as have been described. It assumes that the general fabric of behaviour in the developmental context is homogeneous across the two populations. From a theoretical point of view, the description of the development of the DS infant as being 'slow' must be seen as superficial.

It was noted above that the observation of differences would be a positive result. If the development of the DS infant is not just 'slow' but rather 'different' then the nature of such differences must be examined. It was argued above (p. 36) that an adequate theory of mental handicap in infancy must be a 'developmental difference' theory, rather than either a 'pure developmental' (e.g. 'slow development') or a 'pure difference' (i.e. deficit) theory. It must now be considered to what extent the current findings contribute to such a 'developmental difference' theory.

5.3 Outline of a 'Developmental Difference'

Interpretation

Findings presented here have emphasised the differences between the cognitive development of the DS and the normal infant. This approach has demonstrated that a 'pure developmental' theory of the handicap - one which describes differences only in terms of a unitary 'rate' of development - cannot be tenable. At the same time, it is clear that differences are not absolute. At a first level of analysis, developmental progress is highly congruent between the two populations. 'Pure difference' theories, which postulate absolute deficiency in the DS population, are clearly not an acceptable alternative. Both similarities and differences must be given adequate recognition. What is required, then, is some framework for theoretically relating the observed differences. Such a framework should offer some interpretation for the general difference between the two populations; it must, however, make it clear that any such general difference is manifested differently during the course of development. Further it must emphasise that development is not merely a forum for such differences to be expressed, but that the differences must also be seen as an integral part of the developmental process: both contributing to it, and being affected by it.

Such an approach would emphasise the processes by which development occurs, rather than the state into which its course may be divided. If population differences could be expressed in terms of such processes, it might then be possible to account for the changing manner in which population differences are expressed with development.

The Piagetian approach has, in general, emphasised 'state' analysis. In the present context, this is typified by Inhelder's (1968) finding that abnormal development could be described using the 'stage' as a unit of analysis. Findings presented in this thesis suggest that, at least for the infant with DS, such a 'state' analysis is not adequate. Error patterns are not consistent with a 'lower' stage than that associated with success on the same task. The heuristic properties of the concept of 'stage' are not evident in this context. On empirical grounds, then, in addition to the theoretical grounds outlined above, it is clear that a shift of emphasis from 'states' to 'processes' must be made.

Such a procedure would concentrate on the acquisition of cognitive processes, rather than their formal properties. This should not be seen as a complete departure from the Piagetian approach. Piaget (1953, 1955) presents an account of acquisition alongside the descriptions of states. This account is a highly technical one, which makes use of specifically Piagetian concepts. In what follows, it is hoped to employ distinctions which do not rely on any one theoretical system. In this way, a more general account will emerge. Consistency with the Piagetian approach will, however, be noted when appropriate.

The distinction to be employed is one between 'high level' and 'low level' organisation of response. The Piagetian 'schemata' may be seen as general response systems. Thus:

"In the domain of sensorimotor acquisitions ... actions become generalised as 'schemata', the organisation of which crystallizes in a relatively constant form".

(Piaget 1971, p.150)

Further, the organisation of action may be seen to consist of different levels of control:

"... the nearest approach of these sensorimotor schemata to the structure of logical thinking is the differentiation of schemata into sub-schemata, with a resultant hierarchical organisation".

(Inhelder & Piaget 1964, p.15)

The concept of hierarchical organisation in the control of action is a familiar one. Miller et al (1960) note that:

"behaviour is organised simultaneously at several levels of complexity" (p.15)

and argue that

"the hierarchical nature of the organisation of behaviour can be taken as axiomatic" (p.16).

Hierarchical structure has been seen as a major tenet of any theory of organisation in development (Sroufe 1977). It has been employed with most precision in the domain of skilled action (Miller et al. 1960), and has been introduced into the study of developmental aspects of skill (Connolly 1970). It is not proposed to follow any of these approaches closely. Rather it is being argued that the dimension of 'level of organisation' is one that has at least face validity in the present context.

Piagetian 'stages' may be seen as 'high level' systems of organisation of response. Thus to interpret behaviour in terms of 'stages' is to employ a 'high level' analysis. It has been argued here that this kind of analysis cannot be adequately performed in the study of the DS infant. It is now possible to discuss this finding in terms of the framework of 'levels of organisation'.

There are certain general characteristics of the normal infant's behaviour in the developmental context which make it possible to employ 'high level' descriptions. The learning or acquisition of cognitive skills appears to take place in a 'holistic' fashion. The infant moves from a state of inaccurate understanding (of certain behaviour in the physical world) to a state of relatively complete understanding. Learning appears to be 'complete' in that repeated assessment will usually elicit repeated success, and thus reveal the infant's 'command' of the problem situation. Moreover, performance on tasks not yet 'understood' will manifest the consistent and coherent application of strategies appropriate to a general state or 'stage' of development. Thus, from the point of view of learning, it seems that the presence of a coherent and 'rational' error strategy contributes to progress, since such strategies can rapidly be replaced by equally coherent successful strategies. The substitution of strategies at a high level therefore enhances the acquisition of permanent, successful strategies - i.e. 'achievements'.

In contrast, the manner in which the DS infants acquire the cognitive skills appears much less to be governed by 'high level' factors. An initial success on a task is often not repeated on a subsequent assessment. It would seem necessary to describe learning in such a case to be 'less complete' than in the normal case. The initial success must be seen in more limited terms, as a specific success on a particular occasion, rather than as an indication of a general 'understanding'. Further, the pattern of response during failure at a task does not constitute the kind of coherent 'hypothesis'

which could be readily tested by the infant, and readily replaced by a more successful one. The pattern of response prior to achievement does not seem such as to increase the probability of the emergence of such achievement by 'preparing the way' for it. The delayed emergence of specific achievements is therefore seen as a secondary phenomenon. It is seen as the result of the general manner in which acquisition and learning takes place.

The interpretation presented here focusses on general processes of acquisition rather than on formal features of development. The empirical work reported here has consisted of the repeated assessment of performance on certain tasks. No direct study of learning processes has been made. The paradigm employed is designed to enable 'diagnosis' or identification of cognitive structure. As such the limitations on its value with the DS population are implicit in the above analysis. If the DS infants do not satisfy the behavioural assumptions fundamental to an analysis of high-level structures, then a different approach is required in any further investigation. A more direct, manipulative paradigm would seem to be necessary. Such a procedure is also called for by the theoretical interpretation outlined above (p.109). Preliminary consideration should be given to the kind of manipulative investigation which would be pursued. It should be possible to identify which specific approaches are likely to be of value, and, perhaps, to make some prediction as to the efficacy of different methods of manipulation.

5.4 Implications for Manipulative Experimentation

An interpretation of the pattern of cognitive development of the DS infant has been presented above. This interpretation gives central importance to the manner in which the infant learns, and sees the observed patterns of achievement - including its general retardation - as being a resultant. Such an orientation clearly calls for more direct experimental investigation of such postulated learning processes, rather than mere inference. Further, it has been argued that such direct, manipulative experimentation is required to avoid the limitations of the 'clinical' assessment approach.

There are a number of different theoretical approaches to learning in the context of cognitive development. Each gives a different analysis of the natural contribution of learning and, as a corollary, makes a prediction about the relative efficacy of different methods of experimental intervention. The approaches range from 'strict behaviourist' interpretations, which concentrate on the specific responses which constitute success in a given situation, to cognitive-structural approaches which concentrate on high-level strategies of response characterising behaviour in a range of situations. Corresponding to this range in level of analysis is a distinction between favoured approaches to intervention. The former 'strict behaviourist' approach (see Bricker & Bricker 1973) emphasises the training of specific responses. Learning is seen to arise from the repeatedly successful (or otherwise reinforced) employment of such responses. The latter (cognitive-structural) approach predicts that permanent acquisition will only take place if changes occur at a high level. Such changes can take place in a manner largely independent of

specific responses. The most effective method of intervention should, therefore, operate at the level of general 'schemes'. The cohesion of such 'schemes' makes it possible to set up 'conflict' situations between rival schemes, as a result of which the more adequate scheme will be adopted. Such a high-level change will then necessarily lead to response changes at the level of behaviour.

The interpretation presented here for cognitive development in the DS infant (p.120) can be seen to have implications for intervention, in view of the above distinctions. It would not favour the kind of 'high-level' approach described above, since it claims that the behaviour of the DS infant does not justify such interpretation. It would predict that a technique aimed at creating 'conflict' at high levels of cognitive functioning would be unsuccessful. It would, indeed, claim that such conflict situations are unlikely to arise or to be easily evoked.

To the extent that stronger forms of the cognitive-structural approach are not compatible with the overall interpretation presented, the emphasis must be towards more 'behaviourist' approaches. However, there are reasons why the stronger forms of this system would also appear inappropriate. It is not being claimed that there is no order or structure within the responses of the DS infant. It is not necessary to conclude that each single achievement must be constructed out of a series of random responses. The overall similarity of the results of development - in terms of a sequence of achievements - indicates that a total absence of structure cannot be postulated. What is being claimed is that structure must be seen at a lower level with the DS infants: i.e. at a level less far removed from specific responses than is appropriate for the normal infant.

A 'pure' training approach is therefore not seen as an implication of the interpretation presented here. As will be discussed in the next chapter, there are also methodological limitations on such an approach, in the context of cognitive development. The strongest forms of 'cognitive-structural' approaches however - those which make the strongest assumptions about the degree of organisation of response - are also, clearly, not indicated. What seems to be required is an approach which can transcend specific responses, but which does not overestimate the degree of organisation in the DS infant's response system. Such an approach, if found, should offer an appropriate technique for enhancing performance in the DS infant and, at the same time, give an insight into the actual process of learning in these infants.

The following chapter presents an investigation of this possibility. Before experimental work is described, a more detailed account of the background to manipulative intervention with cognitive development is given.

CHAPTER VII : MANIPULATIVE EXPERIMENTATION WITH DS INFANTS

(Experiment 6)

1. Introduction

1.1 Manipulative Investigation of Cognitive Development in Infancy

The experimentation reported thus far has taken the form of the assessment of development. It has therefore been relatively non-manipulative. It could be argued, of course, that any direct assessment - and especially repeated testing - must inevitably have some influence on the subject's development. In general however, it has been assumed that the results of experimentation can be taken to represent the 'spontaneous' or natural status of the infant, at that time. For the reasons presented above (p.121) it was decided that more direct, manipulative experimentation was required to carry forward the study of cognitive development in the DS infant.

Since Piaget's (1953, 1955) original studies, the impact of specific environmental effects has been seen to be strictly limited by the infant's general 'level' of development (as defined by Piagetian procedures). This standpoint is not conducive to the prosecution of manipulative research. Such research, however, began to be carried out at certain centres, following the 'rediscovery' of Piaget by Anglo-American psychology (Ripple & Rockcastle 1964). Partly as a response to this experimental activity, manipulative studies began to achieve more prominence in the Genevan literature (e.g. Inhelder & Sinclair 1969; Inhelder et al. 1974).

Fundamentally, these studies have restated the original position but with the support of experimental evidence. Various methods of short-term intervention have been applied to children at a certain diagnosed level, and any associated changes in performance analysed. Most of this work

has been concerned with school-age children. The results and methodological issues are held to be general however. The findings of this work, and, of equal importance, the critical issues in methodology, will therefore be presented before considering the contribution of other (non-Genevan) sources.

It has been strongly emphasised that the structural approach to cognitive development is not concerned with the performance of specific acts as such. It is general structures, as indexed by such behaviour, that are of interest. The latter cannot be reduced to the former. Hence the demonstration that children can be led to exhibit some specific act as a result of deliberate manipulation is not held to be of interest. In such a case, the specific act will have lost its character of representativeness of the global structure. Instead it is considered necessary to demonstrate at least a minimal degree of generality for what has been acquired. This may involve the investigation of transfer to other tasks or situations which are held to be analogous to that on which training took place. Successful results of training for which such effects cannot be demonstrated - i.e. which cannot be shown to have the 'natural' relationship to the rest of development - are held to be artefactual.

In line with this reasoning, it has been considered legitimate to use a 'train and transfer' paradigm, in which some kind of concentrated intervention on one aspect of behaviour has been evaluated by testing for transfer. Within this paradigm, Genevan research has found that training methods derived from a 'strict behaviourist' methodology have not been effective in leading to 'true' advancement (Inhelder & Sinclair 1969). Any positive, direct results of training have remained isolated

from cognitive structure as a whole. These methodological considerations must be seen as a background to any manipulative experimentation with cognitive development.

1.2 Constraints and Possibilities for Present Study

It is clearly desirable for manipulative experimentation to be concerned with similar tasks to those employed in the previous studies. Considerable information is available on the range of performance on these tasks. Further, any findings related to learning or training should be seen in the broader context of the conclusions of the previous studies. However, it is equally important to avoid the procedure of training the precise skills which are subsequently assessed. Such procedures (see e.g. Brassell & Dunst 1976, 1978) do not meet the methodological requirements outlined above.

It is to be expected that the general findings of the longitudinal study will have implications for the design of manipulative experimentation. It was noted above that the phenomenon of transfer is of central importance to the cognitive-structural analysis of the role of learning. It has, however, been argued (p.120) that the features of cognitive structure which make such transfer possible in the normal infant may not be characteristic of the DS infant. The presence of high-level organisation of responses is taken to be a prerequisite for transfer. If the proposed interpretation of the behaviour of the DS infant is correct, then the generality of response patterns would be predicted to be low. The ready transfer of learning would not be predicted to be a characteristic of the spontaneous cognitive activity of the DS infant. Such transfer could not, therefore, be used as an

independent measure of induced learning. Its absence (for example) after a programme of training could not be taken as an indication that meaningful learning had not occurred, since such transfer might not occur, either, in the 'natural' context of spontaneous development.

There seems, therefore, to be a conflict between the demands of theory and the constraints of the population characteristics. Some degree of transfer, or generality of task responses is necessary in order that valid interpretations of experimentation can be made. However, the possibility for such transfer seems to be severely limited in the population under study.

In considering the limitations of the population, however, it should be reiterated that an absolute deficit is not being proposed for the DS population. Rather, it is argued that the degree of organisation of response is less in the DS infant than in the normal infant. On this basis it should be possible for a minimal degree of 'transferability' to be demonstrated. Such a minimum must be adequate for the theoretical requirements to be met. In the present chapter, several different candidates for such a 'minimal transfer' paradigm will be presented and discussed. Clearly the issue is not merely methodological. If the general nature of responses (especially of correct solutions to problems) is an essential part of achievement, then any limitation of such generality is an important feature of the behaviour of the DS infant.

1.3 Approaches to Training

Techniques for training a subject on a task fall into two broad categories: those in which the subject has a generally passive role, and those in which he has a more active role. The 'passive' techniques include the provision of extensive 'experience' of the task, including the 'revelation' of its solution (e.g. the location of a hidden object) by the experimenter. The subject may also be passively guided into making the 'correct' physical response on the task, and given extrinsic reward subsequently.

It was argued that the subjects in the present study had already considerable experience of the more 'passive' aspects of task solution. For example, during the longitudinal study subjects had frequently been exposed to the experimenter 'solving' the task (following an error). Such a procedure did not, therefore, seem to recommend itself as a short-term training technique. Passive 'shaping' had not been employed. However, since the tasks concerned required spontaneous responses, it was not felt desirable to employ a procedure which might lead to the inhibition of active behaviour on the part of the subject. It was anticipated that some degree of physical involvement by the experimenter might be necessary. It was not however considered appropriate for this to replace spontaneous behaviour on the part of the subject.

It was therefore considered desirable to select some technique which retained the active role of the subject, but which included experimental control over certain stimulus features. Terrace (1963) has reported the technique of 'errorless learning' in the context of

discrimination learning in pigeons. The classical procedure presents to the subject two stimuli to be discriminated. Presentation is at full intensity, and is simultaneous, from the start of the learning trials. Response to one stimulus is subsequently rewarded, and to the other either punished or not contingently reinforced in any way. Terrace (1963) reported that learning proceeded faster (took less trials to criterion) when, by contrast to the classical paradigm, subjects were initially introduced only to the positive stimulus (response to which was rewarded). The negative stimulus was introduced subsequently at low intensity. This stimulus was gradually 'faded' up to an equal intensity with the positive stimulus. Correct discrimination was retained during this procedure.

A modification of this procedure has been used successfully in teaching mentally handicapped children to discriminate colours and weights (Cullen 1976). Response to one stimulus (e.g. one colour) is first established on its own. The second stimulus is then 'faded in' (e.g. by increase in the intensity of hue). During this period, incorrect responses may be physically prevented by the experimenter. Response preference for the positive stimulus is retained during presentation of the complete discrimination problem. The employment of this procedure has attractive features in the context of the mentally handicapped child. The 'errorless' nature of learning in which no 'mistakes' are made contrasts strongly with the child's more usual experience of failure in everyday problem-solving situations (see Zigler, 1973).

It was decided, therefore, to employ certain features of this approach in a training technique for tasks assessing cognitive development. It should however be emphasised that the kinds of tasks concerned differ markedly from the discrimination-learning paradigm. In the cognitive-developmental tasks retrieval of an object is seen as a valid and meaningful act, and one which is presumed to have certain intrinsic reward value (whatever status such reward plays in a given theoretical system). With the discrimination-learning paradigm, selective preference is only meaningful in the context of contingent, extrinsic reinforcement.

Without neglecting these important differences, there would seem to be certain general features of the 'errorless learning' technique which could be applied in the present context. It is possible that errorless performance might be obtained (and maintained) if additional featural information were to be provided to the infant in a certain task. Some physical restraint might be necessary to prevent incorrect responses. The transition from the 'training' version of the task to the 'testing' version (i.e. from one with enhanced featural information to the standard version) might be seen as a kind of 'fading' in of the standard version of the task. The next section describes the design of a specific training procedure.

2. 'Switching' Task

2.1 Design of Training Procedure

It was decided to first devise a training procedure for the 'switching' task, in which an object, concealed beneath one of two opaque cups is moved non-visibly by transposition of the cups. It has

been found (Neilson 1977) that a task of similar difficulty is created by using transparent plastic cups instead of opaque ones. It might be anticipated that, despite such an initial equivalence between the two versions, the extra perceptual information present for the 'transparent' version might become available to the subject after a number of trials. That this is the case is suggested by the earlier emergence of cognitive skills (on longitudinal testing) when transparent cups are used (Neilson 1977). Errorless performance might be obtained on this task, perhaps with some physical restraint on incorrect responses. A transition from the transparent to the opaque condition might then be seen as a 'fading' in of the full version of the task (since direct perceptual cues to correct response would no longer be present).

In view of the limitations on the use of transfer across tasks as an experimental procedure, however, it was decided to search for a less demanding level of generalisation. It was observed that patterns of incorrect response on the 'switching' task often took the form of a 'side' preference for this task: i.e. that all responses were to the same side (left or right to the infant), irrespective of the side of origin of the object. This pattern could not be attributed to a simple 'handedness', since, first, it usually survived restraint of the preferred hand, and, second, it was not consistent across other tasks in the same session.

It was reasoned that the transparent-cup version of the task might be used to train the infant against this side-bias. If training were only conducted with respect to this one direction of transposition (e.g. object starts left, is retrieved right) then subsequent success on the

standard task (involving both directions of transposition) might be seen as sufficient generalisation for methodological purposes. This 'side-to-side' generalisation might be seen as a 'minimal transfer' situation.

One infant was selected from the subjects of the larger DS study (S_1 of that sample). This subject had only once demonstrated success on the task (to the criterion of consecutive responses for the two directions of transposition). In general, response patterns were all to one side (the left) although incorrect responses were frequently corrected spontaneously. It was decided to test out the technique with this one subject and consider the results before proceeding.

2.2 Procedure

In addition to standard apparatus and materials, two transparent plastic cups, of the same dimensions as the opaque cups, were used.

The subject was first given 4 trials of the standard task, with opaque cups (with the object starting from alternate sides), RIRL.

Using the transparent cups, the task was then presented for the direction left-to-right only. After two initial trials (to establish spontaneous performance) some restraint was used to prevent or discourage errors (see Results). In general this consisted of the restraint of one arm of the subject, thus discouraging (but not preventing) responses to that side.

When spontaneous correct response had been achieved, retesting was performed on the standard task. Subsequently (for reasons noted below) the subject was presented with the task in which the object was placed beneath the left-hand cup, but in which no transposition took place.

2.3 Results

Performance on the standard task initially consisted of responses all to the left-hand cup (after transposition), with spontaneous correction of errors. For the two unconstrained trials with the transparent cup, the same response as above was made to the left-right transposition. For seven training trials, with some degree of restraint, correct response was made. Finally, for three trials, the correct response was made immediately without any restraint.

On retesting with the standard task, all responses were made to the right-hand cup. Those incorrect were immediately corrected. In view of this reversal of side-preference, the object was hidden twice on the left without any transposition. Response was made to the right-hand cup both times, and immediately corrected.

2.4 Discussion

It seems clear that a simple reversal of side-preference was created with respect to this task. Correct response in the training condition was achieved with relatively few trials. On testing with the standard task, however, this specific response was employed for both directions of transposition. Indeed, even when transposition was omitted from the task, concealment at the left position was responded to with search at the right. The brief training session appeared, therefore, to have created a general preference for the other side from that initially favoured. Thus a substitution of preference occurred, rather than any generalisation of the successful retrieval of transposed objects.

It would seem that the 'switching' task, with its simple left-to-right and right-to-left structure, might be vulnerable to the operation

of side preferences (whether spontaneous, or brought about by manipulation). This does not mean that the paradigm of training 'on one side' might not be, in principle, a useful one. Certainly the requirements of 'minimal transfer' would seem to be fulfilled within such a paradigm. However, it probably requires a more complex task for the principle to be tested adequately.

It should be noted that short-term modifiability of response pattern was clearly demonstrated. The apparent plasticity of response should be seen as a promising indication for manipulation. What was learned, however, as a result of the brief training schedule, appeared to be simply a single response. This should be considered in the light of the predictions made above (p.122).

It was argued above that intervention could not be made at the level of the kind of general response strategy posited for the normal infant (p.123). It was also noted, however, that care should be taken to avoid the training of a single response. It was argued that some intermediate level must be found, and that it was at such a level that effective manipulation would be possible. It would appear that the present technique failed to avoid the training of a single response. It had been hoped that a brief training programme might avoid this result, and retain generality for the response, but this was not the case. It would clearly be preferable for a training programme to include several different responses. A more sophisticated design for training was clearly called for.

Finally it should be noted that the obtained generalisation of the single response in this present case has certain implications. The erroneous application of this strategy to a more simple task, following

its adoption in the context of a more difficult one suggests, as noted above (p. 88) that it is hazardous to assume consolidation for a task previously achieved. (It should be noted that the subject had previously registered success on this simpler task). The formerly successful solution strategy for a task may remain labile and vulnerable to interference when more difficult tasks are being approached with a training system. The possibility of disturbing former acquisition should be borne in mind during any attempted intervention. More generally, it is clear that the transfer of some kind of response strategy can, and does take place across tasks for the DS infant. His behaviour cannot be seen as a sequence of independent responses. Some degree of organisation must be posited, even if it is considerably less sophisticated than that of the normal infant.

The pilot study reported here was clearly not successful in its overall aim. However, it enabled an evaluation of various aspects of the manipulative approach to be made. In view of this evaluation, it was decided to design a second training technique, for a different task. This is reported in the next section.

3. 'Deduction' Task

3.1 Design of Training Procedure

One conclusion of the pilot study reported above was that a task of more complexity than the 'switching' task should offer more scope for facilitative training. The standard 'deduction' task fulfils this requirement, in that it can be seen as consisting of several steps. The object is first concealed under a cup. It is then displaced to a position behind one of two screens, by movement of the cup, and the cup is

returned, still inverted, to its original position. The subject is required to make a clear search of the cup, followed by direct retrieval of the object (see p.81).

It is necessary for the infant to initiate search on the discovery that the object is absent from the cup. The cognitive status of an 'expectation' that the object will be in a specific place is not yet clear. However, it might be predicted that the raising of such an expectancy might enhance the likelihood both of initial search of the cup, and of any subsequent search. The nature of such subsequent search - whether 'global' and undifferentiated, or directed to occluders - would not be expected to be altered by such increased expectancy. Any raising of expectancy for the object to be under the cup should not, therefore, be expected to increase the likelihood of correct search simply as an artefactual result of training. It will be recalled that, during the longitudinal study, the DS infant was more likely than the normal infant to make an incorrect search at occluders (see p.111). For the DS infant, therefore, any raising of expectancy for the object to be under the cup might be expected to increase the occurrence of search at occluders, but not of correct search per se.

The task involves the retrieval of an object from behind a screen, following the 'visit' of the cup to that screen during its trajectory. Clearly the infant must attend closely to the trajectory of the cup, and use this information in subsequent search. If a task could be devised which included these features, and which the infant were able to perform, its inclusion might enable transfer of this strategy across to the complete task.

Two 'training steps' were devised on the basis of these demands. In the first, the cup would go through its standard trajectory, but without leaving the object behind the screen. This step would return the object to its initial position, inside the cup. In the second training step, the cup would be taken through the first part of its trajectory only. It would remain behind the screen, with the object still inside it. Since both steps lead to the object remaining in the cup, the successive solution of these steps by the subject might be predicted to result in an enhanced expectancy for the object to be found there. The second step would also, specifically, call for close attention by the subject to the cup's trajectory, since the cup could remain behind one of the two screens. It was hoped that these aspects of the training steps would, in some sense, transfer to the standard task. It should be noted that transfer at a high level of generality was not being predicted.

It was necessary to design a procedure for presentation of the training steps and the standard task, such that methodological requirements would be met, but also that any transfer would be within the limitations of the subject. In the pilot study noted above, it was attempted to employ 'side to side' transfer. It was decided to make further use of this procedure, but in a way which avoided the problems encountered in the pilot study. If the two training steps were presented with respect to the same side - that is, if the cup first returned from, and then remained behind, the same screen - then a single trial of the standard task might be given with respect to the other side. In that case, a correct response - with the removal of

the screen on this 'new' side - would be novel with respect to immediately prior responses. It could therefore be seen as a valid single trial of the task. The series of 'training steps' and single task trials could be extended to generate a sequence which contained as many single trials of the standard task as were normally employed. In the new sequence, however, such individual trials would be separated from each other by the 'training steps'. It should be noted that the orthodox design of pre-test and post-test with a training period in between - commonly employed in studies of learning and cognitive development - was not adopted here. Training and post-testing were, effectively, interwoven instead of being presented in sequence. Interest was centred on performance during the course of the manipulative procedure, not on performance following its completion (concerning which no prediction was made).

3.2 Procedure

Subjects were four of the DS infants who had participated in the longitudinal study. Mean age was 25.0 months. Subjects had either shown no success at all on the standard deduction task during the longitudinal study, or, following some earlier success, had not demonstrated success in the most recent sessions. Two subjects fell into each category.

Subjects were first presented with the standard task in its usual form (with a maximum of four trials). The special sequence was then administered as follows:

Trial No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
subject's left:	t1	t2			S	t1	t2				S	t1	t2	
subject's right:			t1	t2				S	t1	t2				S

(t1,t2 = training steps 1,2; S= single trial of standard task)

Following the special sequence, the usual (four-trial) form of the standard task was presented again. Since the single trials in the sequence constituted 'post-tests', this presentation was termed the 'final post-test'.

3.3 Results

As can be seen from Table 10, all subjects failed the pre-test. All subjects succeeded in performing the training steps in the sequence. It should be noted that these steps themselves constituted problem-solving situations. Three of the four subjects succeeded on the single trials of the deduction task within the sequence. Due to fatigue and inattention, only two subjects were presented with the final post-test. Of these two, one registered success and one failure.

TABLE 10 Results of Manipulation with Deduction Task (Experiment 6)

Subject no. from longitudinal study	Age (mo)	Pre-test	Training steps	Task trials in sequence	Final Post-test	Previous success on task
S1	19	-	+	+	-	+
S2	22	-	+	+	+	-
S3	26	-	+	+	0	-
S7	33	-	+	-	0	+

Key: + : pass - : fail 0 : not administered

3.4 Discussion

Taking the overall results on the four DS infants who participated, it can be seen that the technique was generally successful. That is, most infants who failed the pre-test on the task were able to demonstrate

success on identical trials when these trials were embedded in a certain sequence of training trials. The design of the procedure ensured that correct response to a trial of the task could not be made merely on the basis of a single, previously rewarded response. Instead more general features of the 'training' trials must have contributed to success. It should be emphasised that special training was not given to the subjects to enable them to perform the 'training steps'. It was, apparently, in the performance of these steps - and in the contiguity of presentation with the standard task - that training or transfer effects occurred. Thus it was the context in which the task was administered that must be credited with the enhancing effect. Some interaction between the cognitive skills of the infant and the actual performance of certain tasks facilitated the performance of the deduction task when presentation of the two tasks was intercalated. Enhancement of performance was therefore achieved by the manipulation of the form of presentation, not by direct training.

4. General Discussion

Following the longitudinal assessment of cognitive development in the DS infant, it was argued (p.120) that response could not be seen as organised on as high a level as in the case of the normal infant. Response patterns could not satisfactorily be summarised in terms of general 'stages'. Rather, much lower-level - or local - features of organisation were posited. The unreliable nature of specific achievements reduced the status of such achievements as parameters of development. It clearly became illegitimate to isolate specific

achievements from the overall context of response pattern, and to construct a model of development on such data.

It was argued that these characteristics imposed severe limitations on the paradigm of non-manipulative assessment. The study of controlled manipulation of response was therefore needed to pursue the analysis of cognitive development in these infants. Further, the results of different methods of manipulative intervention might enable the posited characteristics to be described with greater precision. The postulation of meaningful levels of organisation between the single response and the 'stage' of development stands in need of clarification.

The first method attempted clearly failed to transcend the level of the specific response. No information was obtained with respect to the proposed model. The second technique, however, produced positive results. Instead of presenting some training sequence, and subsequently re-presenting the test task, these two elements were integrated within a single sequence. Under these conditions, and without the necessity for repeated experience on the training elements, successful transfer to the standard task occurred for three out of four subjects.

The absence of training on the 'training' elements is a crucial factor. The 'training' elements were merely performed (successfully) by the infant, not subjected to prolonged training. The state of affairs required for transfer to the standard task did not have to be constructed by manipulation: it already existed. The paradigm merely placed the different tasks in a certain temporal relationship. It presented the task within a structured environment, designed to exploit

the subject's present abilities. In this context, success was achieved.

The absence of success on subsequent presentation of the standard task emphasises that the manipulation had not led to high-level permanent changes. It had enhanced performance by eliciting it within a certain context. Thus, as argued previously, the successful performance on a task cannot be interpreted in terms of 'competence'. It cannot be assumed that some general stage has now been reached. Such success may be highly dependent on support of the ambient environment. As before, also, the corollary applies: the state prior to a specific achievement may be capable of supporting success, given a certain structure in the administration of the task.

The nature of the transfer must still be considered, whatever the status of success achieved with its assistance. It was argued, in discussing the design of the training elements, that the expectancy for the object to be found in the cup should be increased for the standard task, when presented in the training sequence. This appears to have been the case. The influence of the training element in which the cup remained behind a screen was, perhaps of greater significance. It appeared that performance on this task demanded attention to the specific trajectory of the cup, and that some transfer of this process subsequently occurred.

Further consideration will be given to these points below, in comparing the performance of the DS infant with that of the normal infant in the same manipulative context.

CHAPTER VIII : COMPARATIVE MANIPULATION STUDY WITH NORMAL INFANTS

(Experiment 7)

1. Introduction

In the previous chapter, an account was given of a manipulative procedure which enhanced the performance of DS infants on a certain task. The manner in which this enhancement might have taken place was considered. It was emphasised that the procedure should not be seen as a training programme for the specific task. Rather, it should be seen as a technique for harnessing certain skills and making them available in the task situation.

So far, then, consideration has been given to the manipulative technique as a means of clarifying the cognitive functioning of the DS infant. Consideration has not been given to the ways in which differences between DS and normal infants might be illuminated by the employment of this technique. This possibility is explored in the current chapter, in which comparative results are presented for the use of the technique with normal infants. It should be emphasised, however, that such a comparative analysis is to some extent independent of the within-population analysis presented earlier. The results obtained for the DS infants (albeit preliminary) are of interest irrespective of the results for normal infants.

The most striking result for the DS infants was the finding that infants who registered failure on a pre-test of the 'deduction' task might pass equivalent trials of this task when these were embedded in a certain sequence of related trials. The major question for a comparative investigation, therefore, concerns the extent to which such 'enhancement' of performance is possible with the normal infant. Infants

from the two populations may be matched in terms of failure on the pre-test of the specific task. In view of the general findings of this thesis, such matching must be seen, of course, as of limited accuracy. Given initial failure, performance on the standard sequence may be compared.

It has been argued throughout this thesis that the cognitive development of the DS infant must be seen as different from that of the normal infant. In the present context, such a difference would be sought between the responses to the manipulative programme (given equivalence in terms of specific achievement). The mean age of the four DS infants who participated in the study was 25.0 months. Normal infants equated with the DS infants on the basis of failure on the specific task would be younger. From the evidence of the earlier comparative study (Chapter VI) normal infants matched in this fashion would be expected to be aged between 14 - 18 months. If any differences were to be found with respect to the response to a training programme, they would be predicted to favour the older group. The straightforward nature of this prediction should not be obscured by the fact that, in the present case, the older group consists of handicapped infants.

In the present case, the DS group generally showed a positive response to the programme. It might be predicted that the younger, normal group - equated on initial performance - would fail to show such a response. Instead, performance on the trials of the task presented in the sequence would not be higher than that on the initial testing.

If this prediction were validated, then the positive response of the DS infants would have greater implications than have so far been

discussed. A clear difference in the cognitive status of the DS infant and the normal infant would have been demonstrated. If, on the other hand, it were found that normal infants' performance could be enhanced as readily as that of the DS infants, then such conclusions about population differences could not be drawn. The implications for the DS infant considered above (p. 142) would need to be re-considered.

As noted above (p. 126) it has generally been argued that performance inappropriate to a child's current cognitive structure cannot be elicited except by specific training of single responses. As has been emphasised, the present technique avoids such a procedure. Therefore only infants who can pass the task in its standard form should be able to pass it within the context of the special procedure. This prediction that the special procedure will not affect the level of performance of the normal infant would seem to be consistent with the Piagetian approach to the relative status of cognitive structure and learning (see Inhelder et al., 1974). If, against current prediction, enhancement were to occur for the normal infant, careful consideration would have to be given to the theoretical implications of such a result.

So far it has been assumed that normal infants will perform successfully on the two 'training steps'. It is the performance on the 'deduction' trials which has been the focus of attention. It is possible, however, that infants will in fact require training on these steps - that is, they may not spontaneously register immediate success on them. If so, the degree of equivalence with the DS sample - and

therefore the validity of comparison - will be reduced. However, even if this were to be the case, it would still be valuable to compare the effect of the 'enhancement' procedure. If normal subjects were to demonstrate enhanced performance within the special sequence, but only following training on the other steps, then this factor would have to be taken into account in comparing the two populations. It was clearly necessary to recognise this possibility in designing the experimental procedure.

In conclusion then, it was predicted that - in contrast to the DS subjects - normal infants would not manifest enhanced performance within the context of the procedure under consideration. Failure at an initial testing would be associated with failure within the training sequence. No specific prediction was made concerning performance on a re-testing of the task, following the presentation of the 'training' sequence. It should be emphasised that it was performance during this sequence - not after it - that was of greatest interest. Discussion will, however, be made of the findings on this point.

2. Subjects

It was hoped to investigate the behaviour of a number of normal infants for whom a clear failure on the initial task could be demonstrated. It was clearly necessary, however, to avoid subjects too young for the task to be meaningful. This requirement was to be met partially by behavioural criteria in performance. As an additional precaution, however, it was decided to select a preliminary sample of whom the majority would be expected to fail on the task. The anticipated presence of some infants demonstrating initial success on the task would suggest

that the remaining infants constituted a valid sample for the investigation.

Inspection of the results of the earlier comparative study (Chapter VI) showed that for infants between the ages of 14 - 19 months, some 20% might be predicted to register success on the task. The remaining proportion would consist of subjects appropriate for present purposes.

Twelve infants were therefore selected from the subject pool described above (p. 55); two for each month of age from 14 months to 19 months inclusive. There were six infants of each sex in the sample.

3. Procedure

Subjects made a single visit to the laboratory. Apparatus and material were the same as described above for previous experimentation. The session was videotaped for subsequent analysis.

Each subject was given the same series of tasks and trials, with the proviso that in the case of failure at a certain point (described below) certain additional trials were introduced before continuing.

First subjects were given the 'AAB' task as described above (p.40). This was done to provide evidence on the cognitive status of the infant, but also to serve as a 'warming-up' procedure. It was hoped thereby that any failure on the pre-test attributable to non-cognitive factors would be avoided.

The standard version of the 'deduction task' was then given (p.136). Subjects were given a maximum of four trials (on alternate sides) in which to register two successive passes on this task. If they did not, a 'fail' was recorded.

The sequence of trials which was to include individual trials of the 'deduction' task was then administered. The sequence was the same as that described above (p.139) for the DS sample. Thus the two different 'training steps' were both presented to each side of the subject. A single trial of the 'deduction' task was then presented. Thereafter such trials alternated with the presentation of the 'training steps' such that 'testing' was made with respect to the opposite side than that on which 'training' had just taken place. A maximum of four separate trials of the 'deduction' task - embedded in the sequence - were given.

If the infant's initial response to the 'training steps' was not successful, additional training was given. Since both 'training steps' culminated with the object being located underneath the inverted cup, training on these steps consisted of giving additional cues concerning this location. The cup was either tapped on its base, or, if necessary, partially lifted to reveal the object. Such additional training was carried out with respect to both sides (left-hand and right-hand-side). It was continued until the step was successfully performed without such additional cues, after which the standard sequence was continued. In subsequent analysis, a clear record was taken of such additional training. It will be noted that such a procedure was not required with the DS sample (p.142).

Having completed the sequence of trials, including up to four trials of the 'deduction' task, re-testing on the standard version of the task was made. This final set of trials was, however, not always administered, due to subject fatigue.

4. Results

Results are summarised in Table 11. It can be seen that three out of the twelve subjects registered a pass on the pre-test. This proportion is in reasonable accord with the expectation of a 20% pass rate. In terms of the sampling precautions described above, then, it was considered that the remaining nine infants constituted a valid sample.

Of those infants who failed the 'deduction' task in the pre-test, two succeeded on the task within the sequence. The mean age of these two infants was marginally below the mean age of the nine infants. On this basis, the general expectation that the normal infant's performance would not be enhanced by the present technique received support.

In addition to the initial sampling criteria, several behavioural features were observed in order to assess the cognitive status of the infants. Two infants failed to achieve any success on the initial 'AAB' task. These infants might be described, in formal terms, as 'not ready' for the deduction task (Piaget 1955). This was in contrast to the DS infants in Experiment 6, all of whom had (previously) registered success. The same two normal infants (only) required extra training on the individual steps in the sequence. For the purposes of obtaining comparative data, for subjects formally matching the DS infants, it was considered legitimate to eliminate these two subjects from analysis. Having done so, it was found that one subject out of seven had succeeded on the task within the sequence, following initial (pre-test) failure.

This finding enabled a comparison to be made with the DS infants, of whom 3 out of 4 were successful on the trials within the sequence

following pre-test failure. Fisher's Exact Probability test was carried out to determine whether the difference in performance enhancement between the two groups could be considered significant. Exact probability was found to be $p=0.085$ (one-tailed). The observed difference therefore fails to reach significance. The result is however suggestive of a superiority on behalf of the DS infants.

TABLE 11 Results of Manipulation with 'Deduction' Task for Normal Infants (Experiment 7)

Subject	Age (mths)	AAB task	Pre-test	Performance within sequence		Re-test
				Elements without extra training	Trials of 'deduction' task	
S ₁	18	+	+	+	+	+
S ₂	19	+	-	+	-	-
S ₃	15	+	-	+	-	-
S ₄	17	-	-	-	-	0
S ₅	16	+	+	+	+	-
S ₆	15	+	-	+	-	-
S ₇	17	+	-	+	+	-
S ₈	18	+	-	+	-	0
S ₉	14	+	+	+	-	0
S ₁₀	14	+	-	+	-	-
S ₁₁	19	+	-	+	-	0
S ₁₂	16	-	-	-	+	-

Key: + pass
 - fail
 0 not administered

5. Discussion

In contrast to the DS infants, normal subjects generally failed to respond positively to the procedure designed to enhance performance on the 'deduction' task. Numbers of subjects were small, and the level of significance achieved by the difference was minimal. This result should therefore be seen as a suggestive, rather than a conclusive one. Discussion of the implications of this comparison will be presented following a brief consideration of the behaviour of the normal infants as such.

In keeping with expectation derived from the literature, it was predicted that normal infants' performance on the given task would not be enhanced by the simple procedure applied. This prediction received support. One implication of this finding is that the individual trials of the 'deduction' task set within the sequence could indeed be seen as valid trials. That is, the design of the presentation was not such as to alter the character of the task to the extent that it could no longer be regarded as an adequate test. Any enhanced performance within the sequence could not be attributed to purely artefactual causes. Rather, it would have to be attributed to population differences between the cognitive status of the infants.

Most of the normal infants performed adequately on the intermediary steps in the procedure, without specific training. It should be noted that the first of these steps consists of the retrieval of an object from multiple occlusion (a cup behind a screen). In terms of the six stages of sensorimotor development, Piaget (1955, p.81) describes such a task as representative of the same stage (Stage VI) as the 'deduction' task itself. It is therefore of interest that such a clear difference in

achievement was observed for these two tasks. This point will not be discussed further. However it should be noted that the discrepancy between the two tasks is of importance for the evaluation of the DS infants' performance. It could not be argued that their success at this 'multiple occlusion' task indicates a 'dormant' competence for the 'deduction' task. Such an explanation would make an erroneous assumption about the equivalence of the two tasks.

The small size of the present sample precludes further statistical analysis. However it might be noted that only one normal subject out of four passed the final re-test, following a pass within the sequence. This finding emphasises that it is performance within the sequence that is of interest. The sequence is not to be seen in toto as a training condition, for which subsequent performance would be the criterion of effectiveness.

With respect to the normal infant, then, it can be seen that performance on a pre-test constitutes a valid index of the infant's competence. Current cognitive structure is generally stable, and resistant to manipulation. Performance cannot be enhanced merely by presenting a trial of the task in a certain temporal relationship to trials of other tasks which are already in the repertoire.

It is now possible to consider the implications of the differences in results obtained for the DS and the normal subjects. First the posited equivalence between the two samples should be discussed. Formal matching was achieved by selecting those infants who failed the initial testing of the 'deduction' task. It was argued above (p.104) that such a procedure cannot in fact be legitimate, and that such formal equivalence is relatively superficial. Indeed, it is in the deviation from

equivalence that population differences, by their very nature, must be sought. However, it is possible that a failure of matching had occurred which was of a merely procedural nature, and which therefore has no relevance for population differences. If this were the case, then little would have been said about the differences between DS and normal infants.

Two of the DS infants had exhibited success on the 'deduction' task prior to the experimental session (of whom one was successful during the special sequence). It was assumed that the normal infants would not have exhibited such success, if prior assessment had been carried out. If such previous success should be seen as an indication of a stage-like transformation of cognitive structure, then more stringent attention should have been paid to this feature in initial matching. It has been argued strongly, however, that single successes (on the part of the DS infant) cannot be seen in such terms. That is, this feature should not be seen in formal terms as a characteristic on which simple matching can take place. The status of such successes is, it was argued, different for the two populations. Further, it should be noted that both DS infants who had shown no such prior success were successful within the special sequence.

A second area in which formal matching might be argued to have been inadequate is with respect to the current status of the infants in terms of achievement (rather than of failure). It might be assumed (with Piaget 1955) that the 'deduction' task could not be tackled if the 'AAB' task were still to elicit 'place errors' (see p. 40). In comparing the contemporary (same-session) performance of the normal infants with prior

achievement of the DS infants (who were not assessed on this task during the experimental session) a similar pattern is found. For both samples, all infants but one demonstrated success on the task, and the remaining infant demonstrated sub-criterial success (i.e. success for one direction, e.g. left/left/right). Thus, whatever the true role of capacity for this task, no straightforward error in matching took place with respect to it. Thus there is no reason to believe that any simple error in initial matching was responsible for the observed superiority of the DS sample. Even if single previous success on the part of the DS infant were to be interpreted as a 'competence' for that task - an assumption which cannot be justified - no evidence for formal superiority of the DS sample could be found. It must therefore be concluded that the difference observed in results is one which reflects underlying differences between the two populations.

The major variable on which the samples differed was chronological age. This is the variable which the technique of 'equivalent-age' matching attempts to control. It may be concluded, therefore, that the employment of this technique is not legitimate with the present populations. Chronological age cannot be controlled for in a straightforward manner. Neither, however, can it be seen as an explanation in itself for observed differences. Having observed an age-related difference in performance following matching on formal criteria, consideration must be given to the possible causes of such a difference.

In discussing the results of the longitudinal study with DS infants, it was suggested that the observed pattern of achievement might be seen as reflecting processes of acquisition (p.118). If successes appeared relatively isolated - and not integrated into a coherent response strategy -

then it would seem likely that acquisition was taking place in a similar piecemeal fashion. It was argued above (p.123) that it was not likely that successful intervention could take the form of the elicitation of 'conflict' at high levels of cognitive functioning. This argument could be extended to suggest that such a process is an unlikely candidate for the mechanism of spontaneous acquisition. In general, it is implied that the pattern of spontaneous high-level acquisition observed in the normal infant should not be expected in the DS infant. The findings of the present manipulative study should be seen against this background.

In one sense the results can be seen as positive for the DS infants. They were shown to be capable of acquiring a certain competence when formally equivalent normal infants were not. However, the results can be seen from a different point of view, when the more general comparative findings are taken into account. The fact that the DS infants responded positively to the highly-structured programme makes it necessary to account for their failure to acquire the equivalent competence spontaneously. If successful performance could be elicited so readily then the previous - or rather, contemporary - failure during standard presentation is all the more striking. This contrast would seem to emphasise the problems resulting from the procedure of matching on formal grounds. The co-existence of the two kinds of response to the same task - contingent on the context of presentation - is not consistent with the picture of coherent, high-level structure. Formal equivalence would appear to be relatively superficial.

The relative handicap of the DS infants, in spontaneous development, is therefore emphasised by the present results. If developmental outcome had not already been adversely affected, the achievement under consideration would already have taken place. The problem of deliberately eliciting it would not have arisen. It is only because of the population differences in the context of cognitive development that a situation arises in which the DS infants may demonstrate relative superiority. More generally, it is clearly not possible to say that the DS infants are 'better' or 'worse' than the matched normal subjects. The differences cannot be reduced to such a dimension.

The purpose of the present comparative study was to extend the investigation of differences between the two populations by employing a more direct, manipulative approach. This method has revealed differences which are consistent with those found during longitudinal assessment.

CHAPTER IX : CONCLUSIONS

1. Beyond 'Slow Development'

It has been argued in this thesis that a theory of 'slow development' - whether couched in psychometric or in Piagetian terms - cannot be adequate to explain the phenomenon of mental handicap in infancy and early childhood. First it was shown that problems of circularity are associated with the theory, with respect to its claim to explanatory status. Two approaches make it possible, in principle, to avoid these problems. A precise underpinning of neurophysiological evidence would provide a more fundamental level of explanation, and thus avoid circularity at the level of behaviour. The necessary degree of precision is not yet available for such a step to be undertaken. The second approach has been given considerable attention in this thesis. It consists in enriching the behavioural account in the theory such that real predictions can be made. In this form empirical testing may be carried out. It has been demonstrated that such testing fails to support the strong claims made by the theory. The theory can only be seen as expressing certain aspects of the effect of mental handicap on developmental outcome. 'Slow development' is therefore a description, and not an explanation.

It should be noted that varying degrees of status may be accorded 'slow development' within a broader theoretical account. Thus if 'developmental level' is seen as the determinant of behaviour then a theory of 'slow development' will, correspondingly, be seen as a complete explanation of abnormal behaviour. This position is implicit in the Piagetian approach (but see IX: 2, below). If, instead,

development is seen as a general pattern which influences behaviour (rather than determining it) then a theory of 'slow development' can co-exist with theories more directly related to performance. Thus an overall theory of 'slow development' may be seen as compatible with a lower-level account of 'learning difficulties' (e.g. Cunningham 1974). Such an eclectic approach is, in all likelihood, the most appropriate for the immediate concerns of caretaking and education. However, it is unsatisfactory from a theoretical point of view. If a high-level theory of development is found to be inadequate in its predictions to behaviour, then allowing such a theory to retain authority must be counter-productive. If it is tacitly accepted that explanation at a much lower level is necessary, then the problem of accounting for more general aspects of developmental change must be recognised.

Having rejected a theory of 'slow development', it might be thought necessary to account for those similarities which do emerge between the populations. This question transcends the present context: it should be seen as an aspect of the general problem of the uniformity of development. That is, an explanation for the similarities in developmental pattern between the DS and the normal child cannot be separated from the explanation for regularity - or 'canalization' - in normal development (Waddington 1957). Moreover, it should be emphasised that the genotypic difference in Down's Syndrome represents only a fraction of the total chromosomal material. Total differences would not be predicted: the genotype is still that of a human infant.

This thesis has emphasised the occurrence of differences, in order to demonstrate the inadequacy of an approach which ignores them.

However, it should be made clear that the approach being advocated is not a simple 'deficit' model. As noted above (p. 36) neither simple 'deficit' nor simple 'developmental' models have proved adequate in attempting to account for the phenomenon of mental handicap across the life-span. Any differences must be thought of as differences of degree, rather than absolute ones. Further, they cannot be seen as determining the characteristics of mature behaviour but rather as one influence on developmental outcome. The differences will be manifested in different ways during development, since they only contribute to outcome (and do not solely determine it). This approach, then, is the framework of a 'developmental difference' theory. Such a theory does not, like the 'slow development' model, tend to discourage investigation (by the maintenance of a 'Null Hypothesis' of the absence of differences). On the contrary, it immediately leads to questions concerning the nature and varying role of these differences. Further, it encourages the investigation of the contribution of ambient environment to behaviour and to developmental outcome - with the prospect of designing techniques of practical intervention. These implications will be discussed at greater length below (IX: 5).

2. The Contribution of the Piagetian Approach

Arguments have been presented above (p. 9) for the importance of the Piagetian approach to the problem of mental handicap in infancy. Some of these arguments concern the status of the Piagetian system with respect to developmental psychology as a whole. These issues - such as the significance of Piaget's 'Object Concept' for other areas of

development - are beyond the scope of this thesis to evaluate. Some conclusions can be drawn, however, with respect to more specific aspects of the Piagetian approach. On this basis, an assessment of the value and the limitations of the Piagetian contribution can be made. For such an assessment to be adequate, it will be necessary to discuss certain aspects of the system in greater depth than has been appropriate in presenting experimental results.

Certain findings of this thesis have been presented as contradictory to a Piagetian model of development. The apparent lack of coherence in the performance of the two initial subjects (p. 42) and, more significantly, the low repeatability of achievement in the larger sample (p. 86) were contrasted with certain assumptions about consistency in development. The form of the Piagetian system employed here was one in which all behaviour is seen as totally determined by high-level 'cognitive structures' to the extent that performance must manifest such structure without distortion by other factors. Further, it was taken that behavioural achievement must reflect high-level change, which could be seen as of a permanent nature (until transcended by further high-level change). Once attained, therefore, such behavioural achievement should be maintained perfectly.

Such an 'ideal' version of the Piagetian system is certainly inaccurate. Piaget (1953, p. 214) notes that behaviour patterns may appear sporadically prior to the stage of which they will be characteristic. Behaviour patterns may be 'transitional' with respect to two clear stages; this term is of most methodological importance in

connection with 'concrete operations' (e.g. Piaget & Inhelder 1969), but is also discussed with respect to sensori-motor (i.e. infant) development (Piaget 1955). Thus the Piagetian model is much less rigid than has been assumed at certain points in this thesis. For this reason, the findings reported here should not be seen, in themselves, as a challenge to Piagetian theory. In this connection, however, they emphasise the importance of avoiding the employment of over-simplified versions of the Piagetian system. This point will be developed further below.

The fact that present findings cannot be seen as the 'falsification' of Piagetian claims does not diminish their potential importance. The findings on which most weight has been placed demonstrate differences between the DS and the normal population. These differences do not rely on any specific reading of Piagetian theory. In general, they concern features which are recognised, but not emphasised, by the Piagetian approach. On a range of such features - concerning the nature of error patterns, and the longitudinal pattern of achievement - it has been shown that deviations from an 'ideal' pattern are significantly greater for the DS population. In investigating such 'deviations' it is clear that a step outside Piagetian theory has been taken. While recognising the presence of 'noise' in the system, and taking it into account when analysing behaviour, it is with the 'signal' of development - as expressed in formal terms - that Piaget is always most concerned. Where differences are observed, they must be accounted for in terms of formal structure. This approach has not been adopted in this thesis.

However, in view of the possibility that a somewhat impoverished version of Piagetian theory may have been employed, this issue requires more detailed consideration. The clearest examples of these problems in interpretation occur in considering the findings of Inhelder (1968). As noted above (p. 18) it is claimed by Inhelder that:

"(there is) no room for doubt as to the structural identity of the intellectual reactions (between retarded and non-retarded subjects)" (p.285).

If the findings of this thesis can be expressed in terms of 'structural' differences, a clear conflict with the position of Inhelder will have emerged. Such an interpretation would hinge on the definition of the term 'structural'. For Inhelder, its use indicates that the behaviour of all the retarded subjects could be accounted for in terms of the 'normal levels' of development - even if 'oscillation' between different levels had to be postulated. It is this specific usage - in the context of 'disequilibrium' (see p. 18 above) - that must be examined. It is possible that the manner in which Inhelder accounts for apparent deviance - from the pattern of 'homogeneous fixation' at a certain level - is also appropriate to the findings in this thesis. If such were the case then, since 'disequilibrium' does not exclude 'structural identity', 'structural' differences would not have been obtained by this thesis. If, on the other hand, present findings cannot adequately be subsumed under Inhelder's 'disequilibrium' it would be justified to claim that structural differences had indeed been found.

For Inhelder, 'disequilibrium' as a characteristic of mental structure is manifested by oscillation between different levels of reasoning during a single session. The most direct comparison with present findings therefore concerns the manipulative study (Chapter VII) in which enhancement of performance was demonstrated in a single session. Inhelder (1968) describes subjects who exhibit progress between two levels of reasoning, during a session, as demonstrating 'progressive' oscillation (see above p. 18). The achievement gained during the session is seen as a relatively permanent one (as assessed by the subject's verbal justification of his decisions). To the extent that transfer of the DS infants' success (within the special sequence) to a re-test was not demonstrated, it could not be concluded that real and permanent achievement had been made. 'Progressive oscillation' would not appear to be an adequate explanation of the present findings with DS infants.

Inhelder also discusses 'true oscillation', a form of 'disequilibrium' in which the subject demonstrates excessive sensitivity to environmental influences. If the structured presentation of a sensori-motor task can be considered analogous to suggestion in a verbal interview - in that environmental influences are being deliberately controlled - then 'true oscillation' might be invoked as a common explanation. It should be emphasised that this feature was seen as characteristic of only a fraction of Inhelder's (1968) sample. To the extent that the findings of this thesis are being presented as general, the explanation would appear to be less satisfactory. Further, Inhelder's claim for the sufficiency of 'structural' explanations would appear to be weakened by the specific account offered for 'true

oscillations'. This account emphasises the role of non-intellectual factors. For those subjects who exhibit 'true oscillations'

"the ... need for approval is so incorporated in their way of thinking that they cannot decide on any solution. To attribute this trouble to reasoning does not explain it. It isn't sufficient to analyse the intellectual development of the subject; it is also necessary to analyse his affective relationships".

(Inhelder 1968, p. 267)

If this specific account were invoked to explain the current findings, then the inadequacy of the 'analysis of intellectual development' would have to be seen as of general application. The Piagetian emphasis on 'structural' or 'formal' features would then have little force.

Even if formal considerations are not adequate to explain every kind of response in the mentally retarded, they are certainly seen as the basis for a description of the problem. Thus Inhelder's (1968) major claim might be expressed as the sufficiency of a stage theory of development to describe responses. That is, any subject may be described as either 'fixed' at one stage, or as oscillating between several stages (in a variety of ways). However, if single achievements are used to assign subjects to a stage the resulting analysis will be relatively superficial. It is in connection with such usage that the concept of 'oscillation' has been reintroduced (Wohlheuter & Sindberg 1975) to refer to variability in performance across sessions.

The concept of 'stage' must however go beyond single achievements. Those aspects of behaviour which guarantee the legitimacy of 'structural' models must be taken into account. It is with respect to these features that, it has been argued, the DS infant differs from the normal infant.

Clearly, the criteria for assigning a subject to a certain 'stage' or 'level' are different for the infant and for the verbally competent subject. To the extent that some analogy can be drawn between the assessment of sensori-motor and of 'operational' activity, and to the extent that the rejection of a 'stage' analysis is justified for the former, a challenge to the generality of Inhelder's (1968) claim for the sufficiency of a structural analysis is made.

It may be concluded that the results presented in this thesis cannot be adequately explained by reference to the findings of Inhelder (1968). In view of the recognition of 'non-intellectual' factors by Inhelder, however, it is possible that certain aspects of her account should be given attention, independently of the general conclusions. Inhelder, it appears, does not take a 'stage' theory to be a complete explanation. The question of why normal progress is not made is seen as a real problem:

"It is as though (the retardate) lacked the interest, the curiosity, and the general activity which, in the normal child lead the subject to ask new questions and to find the solutions, both of which lead him to superior levels". (p.291)

The stage approach is, here, clearly seen as a form of description which does not pre-empt the need for explanation. Such a view is consistent with that presented in this thesis.

Some general points may be made in conclusion, in evaluating the contribution of the Piagetian approach to mental handicap. First it must be emphasised that the Piagetian system is a most sophisticated one, which cannot be reduced to a simple formula. The theoretical

position which was outlined in the Introduction (p. 23) as a 'Piagetian version of the Slow Development theory' must be seen as a relatively impoverished one, in comparison with the richness of Inhelder's (1968) account. It might almost be seen as a classic psychometric version of 'slow development', but couched in Piagetian terminology. To this extent, the inadequacy of such a position might be seen as incidental to a valid assessment of the Piagetian approach. Criticism has also been offered, however, of claims more central to the Piagetian system. Overall, it is clear that the Piagetian approach cannot offer a complete explanation of the development of the infant with mental handicap. The sections of Inhelder's (1968) account which are most consistent with the present findings are those which are least concerned with purely formal features. An emphasis on such features is perhaps the most characteristic aspect of the Piagetian approach. To this extent, the Piagetian contribution must be seen to be limited.

Positive aspects of the Piagetian approach must also be emphasised. The concern for the behavioural context of specific achievements makes it possible to avoid the circularity of, for example, the 'strong psychometric' approach (see p. 24). This advantage is not negated by the inadequacy of any single account of developmental change. The problems which arise from a simplistic integration of Piagetian and more classical approaches must not prevent the real contributions of the former from being recognised.

3. The Nature of Mental Handicap

In the Introduction (p.36) some consideration was given to different theoretical approaches to mental handicap. There, the implications of such approaches for the investigation of development in the DS infant were considered. Here, the results of the present study will be discussed against the background of available accounts. It will be shown that the findings are compatible with the kinds of result obtained with the older child and adult. To this extent, the present thesis will have extended back to infancy the range of applicability of such descriptions.

In summarising the results of experimental studies with the (post infant) mentally handicapped, Clarke & Clarke (1974) postulate:

"either a lack of a firmly based, well-ordered repertoire of response tendencies enabling the subject to select an appropriate strategy when confronted with a task, or fluctuating motivation to succeed, or both in combination" (p.311)

The findings of the present study could perhaps be summed up by this formula. Certainly the structural component of this analysis corresponds closely with the interpretation given to the present results. It was argued that DS infants had not acquired the kind of cohesive, consolidated response system for cognitive tasks which characterises the normal infant. Therefore the performance of the DS infant could not be accounted for in terms of high-level strategies or rules. Explanation needed to be made in terms of lower-level or 'local' degrees of organisation.

The analysis of Clarke & Clarke goes beyond a purely structural interpretation. This thesis has not considered the role of

motivation, beyond discussing some general features which influenced the design of experimentation (see p. 43). It was noted that orientation and attention to the task was often hard to maintain in the DS infant. For this reason, tasks were not presented in a rigid order. A more specific aspect of motivation was taken into account in designing the manipulative studies. Here Zigler's (1973) emphasis on the deleterious effect of continual failure by the mentally handicapped child was noted in the context of 'errorless learning' (p. 130). Motivational features have not however been considered in discussing findings.

It might be suggested that a purely motivational explanation might be available for the findings presented here. Low values for the reproducibility of successes might be attributed to 'fluctuating motivation to succeed'. The inadequacy of this explanation as a complete alternative is, however, indicated by the nature of error responses. These frequently included 'searching on' after an initial error (that is, correcting) (see p. 106). Such behaviour does not suggest that lack of motivation to succeed could, alone, be responsible for patterns of error. Intuitively, general orientation and interest did not appear to differ markedly between success and error. Further, the findings of the manipulative study - in which performance was enhanced when the task was presented in a certain manner - support the structural interpretation. There seems no prima facie reason why such a great enhancement of motivation might have occurred as to lead to the observed change in behaviour.

A solely motivational explanation would not seem to be adequate. Motivational factors must clearly, however, be conceded some influence.

Such influence cannot be seen as independent of cognitive processes. Those characteristics of behaviour which might be seen as an index of motivational processes are themselves subject to developmental change. For example, with respect to the 'AAB' task there is a clear-cut ontogenetic emergence of the spontaneous correction of error by the normal infant (see p.106). Such 'correction' behaviour cannot, then, be taken by itself as an index of 'high motivation'. In general, the Piagetian approach has emphasised the integrated nature of 'intelligence' and 'affectivity' (e.g. Piaget 1954). Such an interdependence is clearly supported by Clarke & Clarke (above). Certainly the impact of motivational features should not be underestimated. They cannot, however, be seen as a straightforward alternative to a cognitive or structural explanation.

Most theoretical accounts of mental handicap would assume that broadly similar features characterise the whole of the life-span. In this regard, the arguments of Denny (1964) concerning 'spontaneous' learning in the adult would, like those of Clarke & Clarke (above) be expected to be relevant to the infant. Denny (1964) suggested that the mentally handicapped adult experiences difficulty in 'spontaneous' or 'incidental' learning from the environment. The present findings on the effect of specific manipulation of presentation format are consistent with this view. They suggest that the DS infant, while in some sense 'capable' of acquiring an understanding of the task, had failed to do so spontaneously. Thus the kind of everyday experience sufficient to support the normal infant's acquisition has not been adequate for the DS infant. (The question of whether such an equivalence of 'everyday experience' can be meaningful will not be pursued here).

One process by which the more 'incidental' aspects of learning might be expected to take place is 'transfer'. It was argued above (p. 127) that transfer should not generally be predicted for the DS infant. To some extent, the broad, high-level structures characterising the normal infant may be seen as a reflection of the ready transfer between different response systems. The results of learning in one context might be expected to lead fairly rapidly to more general changes in performance. If this were not the case for the DS infant, then a retardation in spontaneous achievements - of the kind described by Piaget - might well be predicted.

With respect to transfer processes, Luria (1963) has noted that:

"when he has assimilated some rule, the mentally retarded child can apply it under new conditions only with considerable difficulty and can only accomplish the operation of transfer of experience ... very laboriously" (p.9; author's italics).

This view supports the present argument. However, it should be pointed out that (in contrast to the approaches outlined above) Luria's account is strictly concerned with the child who possesses language. The above phenomenon is, therefore, presented as an effect of deficient language use. Luria (1963) argues explicitly that the handicap should not be evident in the practical activity of the infant. To the extent that 'sensorimotor' activity has been shown in the present thesis to exhibit differences related to the genetic syndrome, Luria's view is challenged. It would not seem legitimate to exclude the infant from a theoretical account of mental handicap, especially when the findings of research with infants are consistent with those obtained with the older child and adult.

The relevance of the present findings to the theoretical approach derived from Piaget has been discussed above (p. 161). It was concluded that such an approach could not be adequate in isolation. It could describe certain features of developmental outcome in mental handicap, but could not give a complete explanation of them. Performance on tasks designed to assess cognitive development must be analysed in the same way as other behaviour; it cannot be taken as a straightforward parameter of cognitive structure. The general characteristics of behaviour summarised here must be expected to apply equally to performance on 'Piagetian' tasks. The investigation of performance on such tasks must be brought into the 'mainstream' of research into mental handicap, rather than being regarded as an independent approach with its own criteria. Such an integration should be seen as a challenge for both the Piagetian and the more classical experimental schools. From the 'developmental' contribution of the former and the 'difference' contribution of the latter perhaps a comprehensive 'developmental difference' theory might emerge.

4. The Normal Infant

So far, conclusions have been presented which mainly concern the handicapped infant. Consistent with the approach of the thesis, such conclusions have usually been of a comparative nature, and have to some extent held implications for the non-handicapped population. It is now possible to bring together some of these points in considering certain theoretical and methodological implications of the overall results.

The criticism of a 'slow development' theory entails criticism of a certain approach to normal development. If the characteristics of the handicapped population cannot (with any explanatory power) be accounted for by positing a 'slowed-down' version of 'normal development' then the model of normal development implied must also be inadequate. This model explains development as a series of states or steps, through which progress is made at a certain rate in time. A critical extra element in this 'state-series' model is the assumption that the normal child's progress can be taken as a parameter of 'normality' itself. Thus the normal infant is said to manifest normality by 'steady progress through the stages'. Clearly, such an argument is circular. The pattern by which 'normality' is diagnosed is itself defined by the pattern of the 'normal' child.

As with the handicapped infant, then, an account of normal development which is expressed solely in terms of characteristic achievement at certain ages cannot be seen as having any explanatory power. The same argument would apply, mutatis mutandis, to the case of the child with superior intelligence. A satisfactory theory must attempt to explain how and why changes occur. The search for 'universals' in development - e.g. in the context of Piagetian theory - cannot be seen as a solution to this problem. Unless such an approach allows its hypotheses to be 'falsified' by single counter-examples (a procedure whose formal rigour is philosophically attractive) it will merely build up a catalogue of the general incidence of certain phenomena. Such a catalogue could furnish the basis for an enquiry into why such generality exists (for example, in a range of cultures).

The notion of 'universality' would, however, be of little import.

It might well be argued that no established theoretical system relies solely on such 'normative' data. However, it is a model to which various theoretical approaches are often reduced. 'Maturation' theories of development avoid circularity by appealing to changes in the central nervous system which are, in principle, observable independently of behavioural change. To the extent that such independent observation is unavailable - or fails to lead to precise correlation - the problems of circularity arise.

Similarly, it is possible to express many of the Piagetian findings in terms of age-characteristic behaviour. Such a procedure ignores the significance of the framework into which the life-span is divided in the Piagetian system. This is done in a hierarchical fashion, so that, for example, changes between 'periods' are of greater significance than changes between 'sub-periods' or 'stages' (e.g. Piaget 1972, p.56). Further, an explanatory apparatus is set up for the mechanism of transition between states, with which the account of successive states is integrated (e.g. Piaget 1953). However, partly owing, perhaps, to Piaget's own emphasis on the importance of the constant order of succession of stages (e.g. Piaget 1972, p.50), this feature is often seen as the essence of the theory. To the extent that this reduction in complexity is made, the general criticisms of the 'state-series' model must be applicable.

Turning to more concrete issues, the analysis presented here of handicapped development leads to a re-evaluation of certain aspects of normal development. A model of development which assumes a high order of organisation in response systems was found not to be appropriate for

the handicapped population. In terms of certain features which, it was argued, index such organisation, clear differences were shown in favour of the normal population. It might appear from this that a theoretical model which assumes the presence of such organisation in the normal infant would be given support. However the resulting position would be unsatisfactory. Two different theoretical approaches - making very different sets of assumptions - would be co-existing, one dealing with normal and the other with (certain) handicapped development. In view of the present emphasis that population differences are to be seen as differences of degree (p. 117) such a dichotomy could not be justified.

Instead, it is necessary to see the presence of a high degree of organisation in the responses of the normal infant as a positive characteristic. Rather than being included in the theory as a 'given' - as a necessary feature of behaviour in development - the substance of such organisation should be seen as a phenomenon of normal development. As such, it demands investigation in its own right. The differences obtained between DS and normal infants must be seen not only as an indication of the degree of handicap of the former, but also of the remarkable achievement of the latter. One of the major achievements of Piaget has been to demonstrate the developmental (or 'genetic') dimension to children's cognitive structures: that is, the inadequacy of an 'all-or-none' analysis. Piaget argued (1955) that the most fundamental concepts of space and time must themselves be constructed over a period of years. The same argument must be applied to assumptions concerning 'organisation' in infant development. Such a feature cannot be seen as monolithic. Rather, 'organisation' must be

seen as depending on a complex set of processes, including many which are usually considered as 'learning' processes. When clear differences are found between two populations, with respect to these processes, questions are raised about both populations. Thus the perspective derived from a comparative investigation of handicap highlights the complexity and efficiency of the 'normal' system, and focuses attention on those processes which support normal development.

5. General Implications

Discussion of the nature of the handicap in Down's Syndrome has, so far, been concerned specifically with the area of cognitive development. It is possible, however, to consider more global aspects of the handicap. The findings related to cognitive development may be extrapolated to development as a whole. In this way, a more general picture of the DS infant will emerge and implications for intervention in development may be considered.

With respect to cognitive development, the picture emerged of an infant acquiring skills in a laborious fashion. Specific experience would lead to low-level, local change, rather than to global re-organisation of response systems. Development at such levels would therefore take place more slowly than with the normal infant. Further, individual achievements would not immediately enter a 'repertoire' of behaviour. They would remain labile and not fully integrated into a coherent system. The establishment of a consolidated system of responses, within which specific achievements would have a place, would be a later attainment.

This picture of handicaps on learning could be applied to any area of development. In this respect the handicap might almost be seen as a 'physical' one, in that 'mental' development would be only one area influenced by it. The concept of a generalised handicap in learning has been explored by Watson (1966) in the context of the normal, young infant. Watson argued that the young infant could be seen as undergoing 'natural deprivation' in that certain functional limitations prevent him from learning about contingent relations in his environment. These limitations concern such factors as the length of time for response recovery, preventing the young infant from emitting responses quickly enough to enable him to test out different possibilities for contingent relationships. Such a 'handicap' might well be described as 'physical' rather than 'mental'. Without adopting Watson's analysis of the precise nature of the 'handicap' in the normal, young infant, his model of physical or structural constraints on the normal learning process is of considerable relevance to the present discussion. It might be argued that the infant and child with Down's Syndrome is in a permanent state of 'natural deprivation', in which his ability to learn from this environment is severely curtailed. Developmental outcome might be seen as the resultant of such a process operating over time.

Certain features of motor development might be illuminated by this approach. By analogy with mental development, it might be argued that the slow emergence of motor 'milestones' (Carr 1975; Melyn & White 1973) cannot be explained simply by positing 'slow development'. In this area of development, as in any other, delayed achievement must be taken as an effect of handicaps on development. The hypotonia and general

weakness of reflexes at birth in Down's Syndrome (Cowie 1970) and the later deficiencies in fine motor control (Frith & Frith 1974) suggest strongly that there are important differences from the normal case with respect to processes influencing motor development. Such differences are also implied by the advocacy of physiotherapy for mentally handicapped infants (e.g. Hughes 1971). Against this background, it would seem reasonable to assert that one influence on developmental outcome in this area might be a general handicap on learning. In the absence of empirical evidence, it is only possible to speculate on some ways in which the handicap might be manifested in this context.

First the 'uncertain' nature of developmental progress would be expected to apply to such behaviour as locomotion. That is, rather than the child steadily acquiring new skills contributing to independent locomotion, each quickly being used as a foundation for the next, a much less coherent pattern would be expected. The various achievements related to locomotion would be expected to be 'unreliable' in performance long after first attainment. That is, the child would sometimes exhibit, and sometimes not exhibit the behaviour of which he was known to be 'capable'. The extensive 'plateaus' of achievement noted by Carr (1975), in which some apparently well-established ability fails to lead on to new attainments, parallels the way in which cognitive skills apparently fail to become integrated into systems of response.

A second, related prediction concerns the role of the caretaking environment. It would be predicted that enhancement of performance would be achieved by careful manipulation of the environment. In the

context of locomotor development, this might consist of amplifying 'reward' aspects of the situation, either by increasing praise and encouragement or by providing attractive toys to be obtained by the appropriate behaviour. Personal observation suggests that such an increased control over the ambient environment indeed characterises the behaviour of both parents and other care-givers. Essentially, the situation is being construed as a 'learning' context (in which behaviour is seen as plastic, and open to manipulative influence) rather than as a 'maturation' context (in which the caretaker merely provides the opportunity for natural growth).

General implications for caretaking or intervention may be drawn. The infant with Down's Syndrome is seen as acquiring all the skills which characterise normal development in an uncertain and laborious fashion, and in a manner highly dependent on ambient environmental features. The deliberate manipulation of such features is seen as an essential contribution to the enhancement of performance in specific contexts, and, by extension, of development as a whole. The DS infant is seen as in constant need of support. For this reason 'early stimulation' in the first weeks of life (Brinkworth & Collins 1969) is seen as the initial manifestation of such support, rather than as a technique of 'once-for-all' intervention (in the manner of the 'Headstart' programme). This thesis has not been concerned with the newborn infant, but would clearly argue that the handicap is a permanent feature of behaviour, and not capable of total remediation. The cumulative effect of any early intervention must not, of course, be underestimated.

With respect to 'stimulation', the role of environmental support would not, at any time, be seen as the provision of undifferentiated sensory 'experience'. Rather, its role would always be determined by a close analysis of the infant's current behaviour. Intervention would be designed to combine with the infant's own activity in a constructive fashion. Just as the handicap manifests itself differently during development, so must the role of support or intervention be adapted.

The problem of assessment is encountered here. This thesis has clearly indicated the hazards of extrapolating from single 'tests' of the infant's ability. Such a practice must inevitably lead to a misrepresentation of the infant's behaviour. This conclusion (in the context of infancy) is in agreement with that of Clarke & Clarke (1973b), following a discussion of the practice of assessment for children and adults:

"The assessment movement, from Galton and Binet onwards, has depended on single-shot sampling of an area of behaviour, and from this an estimate of capacity inferred ... it is clear that in the severely subnormal this approach can offer little useful long-term guidance". (p.38)

The value of single assessments for screening purposes must not be ignored. However, any usage which assigns a more general validity to the results of a single assessment must be considered unsatisfactory. It is not possible to obtain, in this manner, knowledge about 'status' or 'capacity' from which performance in a wide range of contexts can be inferred. If intervention in a specific context is to be carried out, then the pattern and range of behaviour in that context should first be determined.

Finally it should be stressed that the decision to attempt intervention must always consider whether enhancement of certain behaviour is in fact desirable. Concentration on one area of development might lead to reduced attention being given to other areas. Decisions must be taken in the light of the social and educational importance of different achievements, as well as an analysis of their place within development as a whole. The status of 'cognitive development' in such a scheme remains undecided. Whether the cognitive development of the DS infant should be made the focus of intervention remains an open question. It might be the case that the most important contribution of research in this area is to the conceptualisation of mental handicap and of the role of intervention, rather than to the design of specific programmes of 'early education'. In either event, it will have been of importance to have recognised the limitations of the 'slow development' model, and to have begun the investigation of the complex differences between the cognitive development of the infant with Down's Syndrome and the normal infant.

- Bricker, W.A. and Bricker, D.D. (1973)
Behaviour Modification Programmes. in P. Mittler (Ed)
Assessment for Learning in the Mentally Handicapped.
 (IRMR Study Group 5) Edinburgh : Churchill Livingstone
- Brinkworth, R. (1973)
The Unfinished Child : Effects of Early Home Training on
 the Mongol Infant. in A.D.B. Clarke and A.M. Clarke (Eds)
Mental Retardation and Behavioural Research.
 (IRMR Study Group 4) Edinburgh : Churchill Livingstone
- Brinkworth, R. and Collins, J. (1969)
Improving Babies with Down's Syndrome. Belfast: National
 Society for Mentally Handicapped Children (NI Region)
- Broughton, J. (1970)
The Application of Piaget's Infant Studies to Psychometric
 Testing. Unpublished MS, Harvard University
- Carr, J. (1970)
Mental and Motor Development in young Mongol children.
Journal of Mental Deficiency Research 14 pp.205-220
- Carr, J. (1975)
Young Children with Down's Syndrome. (IRMMH Monograph 4)
 London : Butterworth
- Centerwall, A.S.A. and Centerwall, W.R. (1960)
A Study of Children with Mongolism reared in the home
 compared with those reared away from home. Paediatrics 25 pp.678-699
- Charlesworth, W. (1969)
Surprise and Cognitive Development. in D. Elkind and J.H.
 Flavell (Eds) Studies in Cognitive Development : Essays
 in honor of Jean Piaget. New York : Oxford University Press
- Cicchetti, D. and Sroufe, L.A. (1976)
The Relationship between Affective and Cognitive Development
 in Down's Syndrome infants. Child Development 47 pp.920-929
- Cicchetti, D. and Sroufe, L.A. (1978)
An Organisational view of Affect: Illustration from the study
 of Down's Syndrome infants. in M. Lewis and L. Rosenblum (Eds)
The Development of Affect. New York : Plenum Press
- Clarke, A.D.B. and Clarke, A.M. (1973a)
Mental Retardation and Behavioural Research. (IRMR Study
 Group 4). Edinburgh : Churchill Livingstone
- Clarke, A.D.B. and Clarke, A.M. (1973b)
Assessment and Prediction. in P. Mittler (Ed) Assessment
 for Learning in the Mentally Handicapped. (IRMR Study
 Group 5). Edinburgh : Churchill Livingstone
- Clarke, A.D.B. and Clarke, A.M. (1975)
Recent Advances in the Study of Subnormality. London : MIND/NAMH
- Clarke, A.M. and Clarke, A.D.B. (1974)
Mental Deficiency : The Changing Outlook. (3rd. Ed) London :
 Methuen

- Connolly, K.J. (1970)
(Ed) Mechanisms of Motor Skill Development. London :
Academic Press
- Cornwell, A.C. and Birch, H.G. (1969)
Psychological and Social Development in Home-Reared Children
with Down's Syndrome (Mongolism). American Journal of
Mental Deficiency 74 pp.341-350
- Cowie, V. (1970)
A Study of the Early Development of Mongols. Oxford : Pergamon
- Crome, L. and Stern, J. (1972)
The Pathology of Mental Retardation. (2nd. Ed.) London :
Churchill Livingstone
- Cronk, C.E. (1978)
Growth of Children with Down's Syndrome: Birth to age three
years. Pediatrics 61 pp.564-568
- Cullen, C.N. (1976)
Errorless Learning with the Retarded. Nursing Times 72(12)
Suppl. pp. 45-47
- Cunningham, C.C. (1974)
The Relevance of 'Normal' Educational Theory and Practice for
the Mentally Retarded. in J.Tizard (Ed) Mental Retardation :
Concepts of Education and Research. (IRMR Symposia 12-14)
London : Butterworth
- Dameron, L.E. (1963)
Development of Infants with Mongolism. Child Development 34
pp.733-738
- Décarie, T. Gouin (1969)
A Study of the Mental and Emotional Development of the Thalid-
omide child. in B.M.Foss (Ed) Determinants of Infant Beh-
aviour IV London : Methuen
- Denny, N.R. (1964)
Research in Learning and Performance. in H.A.Stevens and R.
Heber (Eds) Mental Retardation. Chicago : University of Chicago Press
- Dicks-Mireaux, M.J. (1972)
Mental Development of Infants with Down's Syndrome.
American Journal of Mental Deficiency 77 pp.26-32
- Ellis, N.R. (1969)
A Behavioral Research Strategy in Mental Retardation: Defense
and Critique. American Journal of Mental Deficiency 73 pp.557-566
- Flavell, J.H. and Wohlwill, J. (1969)
Formal and Functional Aspects of Cognitive Development.
in D.Elkind and J.H.Flavell (Eds) Studies in Cognitive Dev-
elopment : Essays in honor of Jean Piaget. New York :
Oxford University Press
- Freudenberg, R., Driscoll, J., and Stern, G. (1978)
Reactions of Adult Humans to Cries of Normal and Abnormal
Infants. Infant Behavior and Development 1 pp.224-227

- Frith, U. and Frith, C.D. (1974)
Specific Motor Disabilities in Down's Syndrome.
Journal of Child Psychology and Psychiatry 15 pp.293-301
- Gesell, A. and Amatruda, C.S. (1947)
Developmental Diagnosis. New York : Hoeber
- Graham, F.K. and Clifton, R.K. (1966)
 Heart rate Change as a Component of the Orienting Response.
Psychological Bulletin 65 pp.305-320
- Graham, F.K. and Jackson, J.C. (1970)
 Arousal Systems and Infant Heart rate Response. in H.W.Reese
 and L.Lipsitt (Eds) Advances in Child Development and
Behavior 5 pp.60-114
- Gratch, G. (1975)
 Recent Studies based on Piaget's view of Object Concept Dev-
 elopment. in L.B.Cohen and P.Salapatek (Eds) Infant
Perception: From Sensation to Cognition Vol 2 New York :
 Academic Press
- Gratch, G., Appel, K., Evans, W., LeCompte, G., and Wright, N. (1974)
 Piaget's Stage IV Object Concept Error : Evidence of For-
 getting or Object Conception ? Child Development 45 pp.71-77
- Gratch, G. and Landers, W.F. (1971)
 Stage IV of Piaget's Theory of Infants' Object Concepts :
 a Longitudinal Study. Child Development 42 pp.,359-372
- Green, B.F. (1956)
 A Method of Scalogram Analysis using Summary Statistics.
Psychometrika 21 pp.79-88
- Guildford, J.P. (1956)
Fundamental Statistics in Education and Psychology.
 New York : McGraw-Hill
- Hayden, A. and Haring, N. (1975)
 The Multidisciplinary Preschool Programme for Down's Syndrome
 Children at the University of Washington Model Preschool
 Center. in B.Z. Friedlander and K. Sterritt (Eds) Excep-
tional Infant 3 New York : Brunner-Mazell
- Honzik, M. (1976)
 Value and Limitations of Infant Tests: An Overview. in
 M. Lewis (Ed) Origins of Intelligence. New York : Wiley
- Hughes, N.A.S. (1971)
 Developmental Physiotherapy for Mentally Handicapped Babies.
Physiotherapy 57 pp.399-408
- Illingworth, R.S. (1972)
The Development of the Infant and Young Child. (5th Ed)
 Edinburgh : Churchill Livingstone
- Inhelder, B. (1966)
 Cognitive Development and its Contribution to the Diagnosis
 of some Phenomena of Mental Deficiency. Herrill-Palmer
Quarterly 12 pp.299-319

- Inhelder, B. (1966)
The Diagnosis of Reasoning in the Mentally Retarded.
New York : John Day
- Inhelder, B. and Piaget, J. (1964)
The Early Growth of Logic in the Child. London :
Routledge and Kegan Paul
- Inhelder, B. and Sinclair, H. (1969)
Learning Cognitive Structures. in P. Mussen, J. Langer and
M. Covington (Eds) Trends and Issues in Developmental
Psychology. New York : Holt, Rinehart and Winston
- Inhelder, B., Sinclair, H. and Bovet, M. (1974)
Learning and the Development of Cognition. Cambridge,
Mass. : Harvard University Press
- Jones, O.H.M. (1977)
Mother-child Communication with Pre-linguistic Down's
Syndrome and Normal Infants. in H.R. Schaffer (Ed)
Studies in Mother-infant Interaction. London : Academic Press
- Kramer, J.A., Hill, K.T. and Cohen, L.B. (1975)
Infants' Development of Object Permanence - a Refined Meth-
odology and New Evidence for Piaget's Hypothesised
Ordinality. Child Development 46 pp.149-155
- Lenneberg, E.H. (1967)
Biological Foundations of Language. New York : Wiley
- Lenneberg, E.H., Nichols, I., and Rosenberger, E. (1964)
Primitive stages of Language Development in Mongolism.
Proceedings of the Association for Research into Nervous
and Mental Diseases 42 pp.119-137
- Lewis, M. (1975)
The Cardiac Response during Infancy. in R.F. Thompson
and M.M. Patterson (Eds) Methods in Physiological
Psychology Vol. 1c New York : Academic Press
- Lewis, M. and Spaulding, S.J. (1967)
Differential Cardiac Response to Visual and Auditory Stimul-
ation in the young Child. Psychophysiology 3 pp.229-237
- Ludlow, J.R. and Allen, L.M. (1979)
The Effect of Early Intervention and Pre-school Stimulus
on the Development of the Down's Syndrome Child.
Journal of Mental Deficiency Research 23 pp.29-44
- Luria, A.R. (1963)
The Mentally Retarded Child. Oxford : Pergamon
- Mans, L., Cicchetti, D. and Sroufe, L.A. (1978)
Mirror Reactions of Down's Syndrome Infants and Toddlers:
Underpinnings of Self-recognition. Child Development 49
pp.1247-1250
- Melyn, M.A. and White, D.T. (1973)
Mental and Developmental Milestones of Non-institutionalised
Down's Syndrome Children. Pediatrics 52 pp.542-545

- Miller, D.J., Cohen, L.B. and Hill, K.T. (1970)
A Methodological Investigation of Piaget's theory of
Object Concept development in the sensori-motor period.
Journal of Experimental Child Psychology 2 pp.59-85
- Miller, G.A., Galanter, E, and Pribram, K. (1960)
Plans and the Structure of Behaviour.
New York : Holt, Rinehart and Winston
- Moore, M.K. and Meltzoff, A.N. (1978)
Object Permanence, Imitation and language development in
infancy. in F. Minifie and L. Lloyd (Eds)
Communicative and Cognitive Abilities - Early Behavioral
Assessment. Baltimore : Universities Park Press
- Neilson, I.E. (1977)
A Reinterpretation of the Development of the Object Concept
in Infancy. Unpub. Ph.D thesis, University of Edinburgh
- O'Connor, N. and Hermelin, B. (1961)
Visual and stereognostic shape recognition in normal children
and mongol and non-mongol imbeciles.
Journal of Mental Deficiency Research 5 pp.63-66
- Odom-Brooks, P.H. and Arnold, D.J. (1976)
Cognitive Development in Mental Subnormality.
in V. Hamilton and M. Vernon (Eds) The Development of
Cognitive Processes. London : Academic Press
- Paraskevopoulos, J. and Hunt, J. McV. (1971)
Object construction and imitation under differing conditions
of rearing. Journal of Genetic Psychology 119 pp.301-321
- Piaget, J. (1953)
The Origin of Intelligence in the Child.
London : Routledge and Kegan Paul (First published 1936)
- Piaget, J. (1954)
Les Relations entre l'affectivité et l'intelligence dans la
développement de l'enfant. Paris : Centre de documentation
Universitaire (not available in translation)
- Piaget, J. (1955)
The Construction of Reality in the Child.
London : Routledge and Kegan Paul (First published 1937)
- Piaget, J. (1971)
Biology and Knowledge. Edinburgh : Edinburgh University Press
- Piaget, J. (1972)
The Child and Reality. London : Frederick Muller
- Rogers, S. (1977)
Characteristics of the cognitive development of profoundly
retarded children. Child Development 48 pp.837-843

- Serafica, F.C. and Cicchetti, D. (1976)
Down's Syndrome children in a strange situation :
attachment and exploratory behaviors.
Merrill-Palmer Quarterly 22 pp.137-150
- Smith, G.F. and Berg, J.M. (1976)
Down's Anomaly. (2nd edition) Edinburgh : Churchill Livingstone
- Sroufe, L.A. (1977)
The Organisation of Development. Symposium Overview,
Society for Research in Child Development Annual Conference,
New Orleans
- Stedman, D.J. and Eichorn, D.H. (1964)
A comparison of the growth and development of
institutionalised mongoloids during infancy and early childhood.
American Journal of Mental Deficiency 68 pp.391-401
- Terrace, H.S. (1963)
Discrimination Learning with, and without, 'Errors'.
Journal of the Experimental Analysis of Behaviour 6 pp.1-27
- Uzgiris, I. and Hunt, J. McV. (1975)
Assessment in Infancy : Ordinal Scales of Psychological
Development. Urbana : University of Illinois Press
- Waddington, C.H. (1957)
The Strategy of the Genes. London : George Allen and Unwin
- Watson, J.S. (1966)
The development and generalisation of 'Contingency Awareness'
in early infancy : some hypotheses.
Merrill-Palmer Quarterly 12 pp.123-135
- Watson, J.S. (1972)
Smiling, Cooing and 'The Game'.
Merrill-Palmer Quarterly 18 pp.323-339
- Wishart, J.G. (1979)
The Development of the Object Concept in Infancy.
Unpub. Ph.D thesis, University of Edinburgh
- Wohlheuter, M.J. and Sindberg, R.M. (1975)
Longitudinal development of Object Permanence in mentally
retarded children. American Journal of Mental Deficiency 79
pp.513-518
- Wohlwill, J. (1973)
The Study of Behavioral Development. New York : Academic Press
- Woodward, M. (1959)
The behaviour of idiots interpreted by Piaget's theory of
sensori-motor development. British Journal of Educational
Psychology 29 pp.60-71

- Woodward, M. and Stern, D.J. (1963)
Developmental Patterns of Severely Subnormal children.
British Journal of Educational Psychology 33 pp.10-21
- Zeaman, D. and House, B. (1963)
The role of Attention in Retardate Discrimination Learning.
in N.R. Ellis (Ed) Handbook of Mental Deficiency.
New York : McGraw-Hill
- Zigler, E. (1969)
Developmental versus Difference theories of mental retardation
and the problem of motivation. American Journal of Mental
Deficiency 73 pp.536-556
- Zigler, E. (1973)
The Retarded Child as a Whole Person. in D.K. Routh (Ed)
The Experimental Psychology of Mental Retardation.
London : Crosby Lockwood Staples