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The Development of Representation in Children with Down's Syndrome:

Coherence and Stability

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Summary

This thesis examines the development of representation in typically developing children and in young children with Down's Syndrome. The focus on representation allows us to adopt a general approach to development in infancy spanning domains such as motor development, language, object permanence, imitation, and symbolic play.

Theoretical approaches to children with Down's Syndrome have been dominated by the 'delay versus difference' controversy. This perspective suggests that development in children with Down's Syndrome should proceed with a sequence and structure similar to that observed in typically developing children. In this thesis it is argued, in contrast, that children with Down's Syndrome present a number of challenges to the organisational perspective. This thesis examines the strengths and weaknesses in the development of children with Down's Syndrome and attempts to identify the structural links between domains which are threatened by such a profile.

These results of empirical studies detailed in this thesis suggest that development across domains such as language, motor development and object permanence appears to be relatively coherent. However, children with Down's Syndrome show subtle differences in their performance on object permanence and symbolic play tasks which suggests deviation from the typical pattern of structural coherence. Specifically, children with Down's Syndrome appear to adopt a more imitative strategy in solving object permanence tasks and in their symbolic play. The prevalence of imitation as a strategy may be indicative of a shallow level of processing. Alternatively, it may also be argued that children with Down's Syndrome adopt a different representational style in performing tasks. These subtle difference in the style with which children approach task suggest that the learning and consolidation process may differ between children with Down's Syndrome and the typically developing population. Such findings may have important consequences for intervention.

Abbreviations

The following abbreviations are used in this thesis:

BSID	Bayley Scales of Infant Development
DS	Children with Down's Syndrome
ME	Means-Ends
MLU	Mean Length of Utterance
NDS	Non - Down's Syndrome (i.e. Typically Developing Children)
NS	Non - Significant
OP	ObjectPermanence
TOM	Theory of Mind

Chapter 1

The Development of Representation

1.1 Aims of this thesis

This thesis is motivated by two considerations: to demonstrate how an understanding of representational processes in children with Down's Syndrome can enhance an understanding of developmental theory in general and to inform strategies for interventions targeted at children with Down's Syndrome. The focus on representation is an attempt to identify ways in which developmental processes are similar to, and different from, those of typically developing children. The study of representation provides us with a means of linking domains of development which may traditionally be regarded as separate and conversely, identifying as separate, domains which appear be linked. Furthermore, a theoretically driven account of representational development serves as a basis in identifying areas worthy of empirical investigation .

In this chapter, and the five introductory chapters which follow, the development of representation in children with Down's Syndrome is introduced in relation to models of typical development. In this first chapter, models of representational development are discussed in general terms as they apply to typically developing children and with specific reference to development within atypical populations. The focus on 'representation' is warranted in allowing us to identify particular theoretical constraints which may be respected or violated in atypical populations. The following chapter, chapter two, discusses the development of children with Down's Syndrome with respect to typically developing children. The subsequent four chapters look at traditional domains of development which, it is argued, are pertinent to the development of representation in infants with Down's Syndrome.

1.2 Aim of this chapter

The aim of this chapter is to contrast our understanding of the way in which development occurs in typical children with the developmental processes implicated in atypical populations. A focus on representations is first justified from the standpoint of typical development. It is argued that representations form the common currency of children's thought processes across a variety of developmental domains. It is clear, however, that the particular definition of 'representation' is crucial to a discussion of its ontogenesis. In the subsequent sections, definitions of representation are introduced and subsequently discussed in relation to global theories of development. The implications of such theories are subsequently discussed in terms of constraints on representational development with a view to interpreting atypical development. The notion of representational development, either as a domain general process or a domain specific process occurring within circumscribed modules, is implicit in many global theories of development. Several such meta-developmentaltheories are introduced in this chapter. Such theoretical views make predictions about the possible courses which development may take and the ways in which strengths and weaknesses may develop. This perspective is therefore particularly pertinent to our concluding discussion of atypical development

1.3 The nature of representation and thought

From the point of view of contemporary philosophy, representations comprise the elements of our thought which may be evaluated semantically. It is the existence of representations, therefore, that allows our thought processes to be justified or corrected. For example, the mediation of mental representations distinguishes between the act of solving a problem and a patella reflex. Without representations our thoughts would, by definition, be without *content*, or meaning. As Russell (1996, p. 4) argues, we would be 'crazy' to do cognitive and developmental psychology without being concerned with a theory of representation, to do so would be to accept the doctrine of behaviourism. The behaviourist denies the existence of mental and cognitive processes and accounts for mental states simply as dispositions to behaviour. The behaviourist school of thought has failed, largely as a result of its inability to explain how identical behaviours could be driven by different mental states.

Given this compelling argument for the role of representation in developmental psychology, albeit due to the failure of behaviourism, boundaries for our discussion need to be established. Developmental psychologists are primarily concerned with the ontogenesis of representational thought and the consequent representational status of the child's mental processes. However, there is an identifiable tendency in developmental psychology to be concerned solely with the empirical demonstration of emergent representational capacities without sufficient concern for a definition (McShane, 1991). Many of the discrepancies between empirical results concerned with early representational capacities amount to little more than the semantics of their competing definitions. Defining exactly what is meant by a representation is therefore a central, and much neglected, problem in studying the development of representational systems.

1.3.1 What is representation?

The classical definition of a representation, according to Pierce (see Tereja, 1988), is as one element in the pair comprising sign-and-signified or form-and-meaning. For example, a picture can represent something, its *referent*, as being a certain way (*sense*). Representations can comprise pictures, models, sentences and mental states but, some would argue that the representations should be restricted to either arbitrary, or purely conventional, relationships between the representation and the represented. Some forms of 'representation' do bear some resemblance to their referents, for example an aerial photograph of a town or a child's picture of her mother both, to a varying extent, resemble that which they depict. Other 'representations' have a causal connection to the signified, such as clouds representing rain. Language, in contrast, provides a clear example of an arbitrary relationship between the representation itself, a word, and its referent. These linguistic relationships are established solely through social conventions and hence there is no similarity between the word *dog* and the dog itself.

Clearly, any definition of representation must specify the degree of similarity and causal connection between the hypothesised representation and that which it represents. Perner (1991) argues in this respect for a distinction between *primary* representations, in which there is close causal contact between the representation and the world, and *secondary* representations which are purposefully 'decoupled' from reality. In order to qualify as secondary representations, these must go beyond direct copies of reality to 'evoke something else' (Perner, 1991). A secondary representation therefore represents something as 'being a certain way' (Perner, 1991). The distinction between that which is represented and the meaning which is afforded by the particular representation is sometimes referred to as the distinction between *sense* and *referent*, or between object and content. Gottlieb Frege (1892/1960) commented that although people refer to the 'Morning Star' and the 'Evening Star', both expressions refer to the planet Venus. Here both expressions refer to the same object (referent) but differ in their content (sense), i.e. meaning. Perner's model allows us to ascribe a truly representational status only to secondary representations, and to dismiss primary representations as being mere reflections of reality. Such a distinction is similar to a distinction drawn between representations of actual (primary) and hypothetical (secondary) states of affairs, which was central to Piaget's account of the development of representations (Piaget, 1953/1970).

The philosophical issues here focus on the similarity of our internal representations to our perception of external reality. It was Hume's belief that mental representations comprise both *ideas* and *impressions*, and that these differ only in terms of the 'force and violence' with which they reflect reality (Bricke, 1980). Hume's *impressions* are essentially direct copies of perceptual elements and it is from these impressions that fainter *ideas* could be derived. Hume's ideas, being derived from perceptual input, would fall into Perner's category of primary representations - by virtue of their similarity and causal connections with reality. Given that thoughts proceed on the basis of hypothetical states of affairs which may not be derived from perceptual input, the Humean position leaves only a limited role for representation in thinking. In this sense, the relationship between internal and external representations itself dictates the role for representation in thinking.

If representations are no more than primary derivations of external reality, as Hume suggests, then the role for representation in thinking is indeed limited. An alternative view, such as that proposed by Perner (1991), is that our internal representations are, by definition, divorced from reality and therefore assume a central role in thinking. Questions surrounding the relationship between internal representations and external reality can therefore be seen as constraints on the relationship between representation and thought. In order to establish a theory of representation which is pertinent to typical development one first needs to establish its role in adult-like thought processes. We will now turn our attention to the precise relationship between definitions of representation and the nature of thought in adults.

1.3.2 How does thought relate to representation?

Mental representations were introduced as central to understanding behaviours driven by mental states. Thus, an adult may look into a biscuit tin driven by the belief that it contains desirable biscuits, but one would not seek to explain a patella reflex similarly in terms of beliefs and desires. The adult's problem solving behaviour can be justified with reference to mental states while the reflex action cannot. It is the very nature of cognitive processes which permits such semantic evaluation and this is often referred to as having *content*.

The relationship between representations and thought processes hinges upon whether representations have inherent content or whether this content must be extracted or interpreted by some higher order process. Cognitive processes no doubt involve the use of representations but the driving force behind these processes, beliefs, desires, hopes, etc., so called *propositional attitudes*, are difficult to account for in purely representational terms. In terms of searching for a biscuit, behaviour is driven by the *belief that the tin contains desirable biscuits*. A representational account of propositional attitudes is particularly problematic if we accept Hume's narrow and primary view of representation which would only stretch as far as a perceptual impression e.g. *the tin contains desirable biscuits*. We are therefore left with a choice, either to broaden our definition of representations to encompass propositional attitudes or to draw a clear distinction between representing something and thinking something.

If a narrow definition of representations is accepted, such as that proposed by Hume, then we are left with a homunculus problem. Such representations do not have content, i.e. do not 'mean', and therefore require an interpretant (Pierce, see Tereja, 1988). This homunculus problem invariably crops up whenever we require the semantic content of representations to be extracted or interpreted. One possible solution to this problem is to establish a model of thinking which proceeds without the need for semantic evaluation. If representations have inherent content they do not therefore require interpretation. Such a solution was proposed by Fodor (1987). Fodor argued by analogy with computers that representation and meaning are integrated in the formal symbolic properties of thought. This symbolic language is termed the Language of Thought (LOT) and thinking is therefore reducible to symbolic processing (Pylyshyn, 1984). These symbolic processes require no more interpretation than that expected of a computer 'interpreting' a binary code. Propositional attitudes are nothing more than boxes, a 'belief' box, an 'intention' box, etc., and actions are driven by the contents of these boxes. According to this view the mind essentially becomes a syntactic engine rather than a semantic one. The main problem with this account is it reduces semantics to syntax of thought and this does not reflect our folk psychological view of how we go about the business of thinking.

It would appear that the adoption of a particular view of representation dictates the role for such a system in adult thought processes. However, the impetus behind the current discussion is to develop an understanding of theoretical constraints which may be applied to the development of thought in children. The following discussion focuses on theoretical issues surrounding representational development in typically developing children.

1.4 The development of representation in typically developing children

Whether we believe that internal representations take the form of computational symbols (e.g. Fodor) or mental pictures (e.g. Hume) we are left with a problem of how representations, whatever their form, come to exist for the child. It is clear, however, that the process by which representations develop must itself depend on the nature of representation. The adequacy of the child's initial, a priori representations and the subsequent developmental processes are the subject of much theoretical speculation ranging from wholly empiricist to wholly nativist accounts.

1.4.1 The ontogenesis of representation: nativism vs. empiricism

William James characterised the young infant's mind as a 'blooming, buzzing confusion' suggesting the absence of any native representational organisation (Myers, 1986). Locke took a similar view of the initial state of the human mind as an empty room waiting to be furnished or a *tabula rasa* (blank slate) awaiting experience (Lowe, 1995). Locke's view of the mind as a tabula rasa epitomises the empiricist sentiment that 'there is nothing in the intellect which was not first in the senses'. However, to many developmental psychologists and philosophers, such an absolute denial of native knowledge is untenable. Kant argued from a philosophical standpoint that we need some constraints on our experience in order to explain our subjective conceptions of time, space, and causality (White, 1996). However, Kant's position is often, wrongly, attributed to nativism. On the contrary Kant argued that knowledge of the properties of space and time was a form of rational intuition, integral to perception, and not endowed by native structures.

Somewhere between the empiricism of Locke and James and a strong nativist view lies Piaget's *constructivist* account of development (Piaget, 1953/1970). Piaget believed that representation was neither an innate property of children's minds nor could it be derived wholly from experience. Piaget's central thesis is that children are endowed with a number of simple schema which are essentially reflex actions, such as the suckling or grasping reflexes. These schema are subsequently modified and reorganised in the light of experience and environmental feedback. Development thereby occurs as a result of successive internal reorganisations of existing action schema. What distinguishes Piaget's account of development from an empiricist view is that experience is invariably interpreted according to pre-existing schemata and thereby represented internally. However, Piaget did not attribute representational status, even in its narrow form, to the child's early schemata. The earliest schemata are nothing more than reflex actions. Representations, according to Piaget, arise as a result of the internalisation of action, a process which does not begin to occur until around 18 months of age. Before the internalisation process is complete the child's thought processes occur, to some extent, through the medium of motor activity.

Piaget saw subsequent development as a series of stagewise transitions during which the child's understanding would undergo a dramatic transformation across a number of domains. Infancy is dominated by the sensorimotor stage which occupies the period from birth to 18 months. The child's thought develops as a capacity to internalise actions in the form of symbolic representations. Development progressed from the sensorimotor stage, through the preoperational stage, concrete operational stage and finally the stage of formal operations.

Fundamental to Piaget's view of sensorimotor development is that thought is an internalised representation of action. The adequacy of a child's thought processes are reflected in their structure. Structural reorganisation occurs through the co-ordinated processes of *assimilation* and *accommodation*. Assimilation is the process by which currently existing schemata are applied to experience and is seen as the motivating force behind development. Accommodation is a failure-driven process which results in the modification of schemes and addition of new schemes into the child's repertoire. This process of development is often referred to in terms of a dynamic equilibrium between assimilation and accommodation or between the desire to impose an existing framework on experience and to construct a new framework.

Central to Piaget's constructivist account is the denial of native knowledge. Piaget attributed to the new born child only a limited number of reflex actions and some constraints on the restructuring process. Piaget believed that the child's psychological starting point was with inadequate representations of space, time, objects, and causality. However, many criticisms of Piaget focus on his denial of adequate native representational structure (Russell, 1996). For example, Piaget believed that the world of the new-born child was one characterised by egocentricism in which the child fails to distinguish between herself and the world. Piaget postulated that the child acquired an allocentric, or world-centred, view through cumulative experience of action. Many philosophers regard the notion of allocentricism arising from egocentricism as untenable (Hopkins, 1987; Campbell, 1993). Technically the philosophical argument centres on what must be known 'a priori' and what can be constructed on the basis of experience and reason. While Piaget acknowledges some 'a priori' knowledge in the form of native structures, many would argue that Piaget in this respect, did not go far enough (Russell, 1996; Karmiloff-Smith, 1992/1995).

A second fundamental problem with the Piagetian account of representational development is its insistence on general stagewise representational changes reflected in children's success on particular tasks. Such a model has been challenged by a weight of empirical evidence showing that children's success on such tasks is sensitive to minor modifications (Donaldson, 1984; Baillargeon, 1991). Furthermore, discrepancies between domains of development which have been observed demonstrate the absence of coherent general stagewise development (Cromer, 1994; Fodor, 1983).

More recent neo-Piagetian accounts of development have modified some of Piaget's less celebrated views, particularly his denial of native structure and the notion of domain-general representational change. A more prominent role for innately specified knowledge is suggested by Karmiloff-Smith (1992/1995). Karmiloff-Smith posits native structure in the form of attentional biases or predispositions towards particular types of environmental input. Like Piaget, Karmiloff-Smith believes that the child adds new representations on the basis of interactions with the world and modifies existing representations to reflect new acquisitions. However, while Piaget argues that representational development is driven by the inadequacy of existing representations, Karmiloff-Smith argues that the child is motivated by the successful application of such representations. Thus, Karmiloff-Smith's account of developmental progress is success rather than failure-driven. In this sense representational change is preceded by behavioural mastery rather than as a process fuelled by conflict as proposed by Piaget.

Karmiloff-Smith's (1979, 1992/1995) neo-Piagetian account of the development process is termed *representationalredescription*. The process of representational redescription takes place within microdomains, or circumscribed areas of representational development. Domains such as the child's understanding of physics are made up of microdomains such as an understanding of gravity. Her account of representational change involves a 'phase transition' within each microdomain. Information is initially encoded at the implicit level and is transformed, after achievement of behavioural mastery, to three subsequent levels of explicit understanding. Prior to establishing behavioural mastery, information is encoded only at the implicit level and a number of constraints are applied to links between representational domains. Karmiloff-Smith illustrates her theoretical perspective with an example of learning to solve a Rubik's cube puzzle. It is initially possible through many hours of practice to achieve behavioural mastery of the Rubik's cube task and thereby develop a 'proprioceptive solution' which can be performed rapidly but not at a slower rate. Eventually this implicit solution is redescribed and thereby transcends the implicit, procedural representation to an explicit representation which is accessible to consciousness. Once the process of representational redescription has transformed the implicit representations into explicit levels, information is accessible to verbal report and open to intra-domain and inter-domain representational links.

Thus, Karmiloff-Smith's account of development recognises the fundamental need to posit innately specified knowledge and furthermore proposes that representational shifts occur within microdomains rather than as domain general processes.

Piagetian models aside, there are a number of developmental meta-theories which seek to explain developmental trends in representational development. Fodor's LOT model of representation, in contrast to Piagetian theory, postulates an innate capacity for the use of mental symbols. This innate symbolic capacity reflects a common representational language, or language of thought. The processing of symbols is carried out by a number of input systems and is regulated by a central processor. Input systems, or modules, with fixed neural architecture provide the translation of sensory input into a common format suitable for central processing. Input modules include a number of dedicated perceptual and linguistic processors. Fodor hypothesised that processing within these modules is both fast, automatic, and insensitive to top down demands of the central system. Additionally, input modules encapsulate information beyond the reach of other modules and provide 'shallow output' only for the central system. Fodor's model accounts for development as an ever increasing processing power of the central system. This process allows the central system to generate top-down hypotheses about the world on the basis of information received from input modules.

Beyond arguments about nativism, what distinguishes Fodor's view from the views of Piaget is his insistence on a modular structure to the mental processes. Karmiloff-Smith also proposes some processing limitations to mental communication between domains of understanding. The extent to which thought can be seen as a modular or domain specific process is pertinent to an understanding of development within typical and atypical populations. This issue will now be addressed.

1.4.2 Modularity, domain specificity and atypical development

The relationship between domains of development is implicit in many views of representational processes in typically developing children. Karmiloff-Smith describes a process of representational change based on representational redescription within micro-domains while Fodor argues for hardwired modules of which only the central system 'develops'. Central to this debate is whether representational development occurs in relative independence within circumscribed domains or occurs as some coherent domain general change as a result of an increase in processing capacity. At the beginning of this chapter it was argued that representation might form the common currency which binds thought processes across domains of development. The extent to which this is true depends on the theoretical position which is adopted.

These unresolved philosophical issues serve to illustrate how representational theories work from the 'inside-out' (Russell, 1996) approaching developmental trends within an established developmental framework and with fixed ideas about the nature of representations. Such a problem is exacerbated by empirical preoccupations in which support for particular theoretical perspectives is often based on studies of typically developing children and carried out exclusively within particular domains such as face-perception and language development. Despite this preoccupation, there are no strong theoretical grounds for treating such domains either as distinct or coherent in representational terms. Empirical evidence from studies of typical development is implicitly conservative. Similarly, studies carried out within domains of development do not contribute to an understanding of relationships between domains of development such as language development or perceptual processing.

Russell (1996) suggests an alternative approach in which we acknowledge that children possess representational forms of some kind but reserve judgement about the nature of representations until we obtain empirical evidence which forces us to constrain our views. This is to argue from the 'outside in' and address the question in the form 'we could not know X unless our experiences had a particular form Y, therefore our experiences have form Y'. Pursuit of such arguments leads to empirical constraints upon the nature of our experiences which may support one or other view of representation.

Recently, a greater emphasis has been placed on the value of extending theories to encompass developmental psychopathology. It is a fundamental premise of developmental psychopathology that, 'we can understand more about the normal functioning of an organism by studying its pathology, and, likewise, more about its pathology by studying its normal condition' (Cicchetti, 1984, p. 1). Although not universally accepted, this premise establishes a reciprocity between our understanding of typical and atypical populations. What this means is that studying developmental processes in atypical populations may reveal continuity or discontinuity which is not readily apparent in typically developing children. The existence of such continuity, or discontinuity, may support or conflict with theoretical accounts of representational development.

A fundamental problem in studying typically developing children is that development may proceed in a rapid and coherent way relative to atypical populations. The chances of establishing precisely which facets of development are genuinely related and which facets merely coincide is therefore more difficult than where development occurs more slowly. Thus when development occurs in an atypical manner or relatively slowly, it becomes easier to distinguish between coincident and necessary developmental relationships. Furthermore, the very nature of disorders such as William's Syndrome, Fragile-X Syndrome and autism are such that children appear to have characteristic, and theoretically informative, strengths and weaknesses.

Much of the recent interest in the development of children's understanding of mental states has been driven by the desire to interpret the apparent lack of such understanding in children with autism (Baron-Cohen, 1987; Hobson, 1993). Theoretical perspectives on the development of children's understanding of mental states are now judged on their ability to encompass evidence from the field of autism. Similarly, children with William's Syndrome who often exhibit stark contrasts between their strengths in language and face perception and weaknesses in number and spatial cognition, are provoking a rush of interest from developmental psychologists interested in theoretical implications of such dissociations (Bellugi, Marks, Bihrle & Sabo, 1988; Karmiloff-Smith, 1992/1995).

The pattern of particular strengths or weaknesses and their developmental characteristics provide evidence which informs our knowledge of both typical and atypical developmental processes. Likewise any fundamental perspective on the nature of representational development must encompass a number of perspectives from developmental psychopathology. In the following section, consideration will be given to the particular ways in which global theories of representational development may encompass evidence from atypical populations.

1.4.3 Developmental meta-theories and the organisation of development in atypical populations

Meta-developmentaltheories, such as those described by Piaget, Fodor and Karmiloff-Smith, specify not only the relationships within domains of development but the common structural characteristics or processes which may bind particular domains together. In specifying either a global or modular structure to developmental processes such theoretical perspectives constrain the variation which may occur between facets of development. An account of such variation within the typically developing population and indeed the variation which characterises atypical development must therefore be encompassed within the constraints applied by theories of meta-development. In this section, the extent to which meta-developmental theories can account for atypical developmental processes will be discussed.

The 'orthogenetic principle' proposed by Werner and Kaplan (1963) suggested a developmental progression from a state of globality and undifferentiation to increasing articulation, complexity, differentiation and hierarchical organisation. Cicchetti, Beeghly and Weiss-Perry (1994) claim to be guided by Werner and Kaplan's organismic-developmental approach in studying children with Down's Syndrome. The organisational approach proposed by Werner and Kaplan suggests that development proceeds via a series of qualitative reorganisations which lead to increasing differentiation and hierarchical organisation of biological and behavioural systems. Hierarchical integration takes place both within and between systems the cognitive, affective and social domains. In typically developing children it is hypothesised that cognitive, affective and social domains of development become increasingly organised and integrated. Normal development is characterised as a successful negotiation of 'a series of interlocking social, emotional and cognitive competencies' (Cicchetti and Beeghly, 1990; p.32). In contrast, developmental psychopathology may arise whenever the development of one system lags behind the other two and therefore precludes higher level integration. The implication here is that early adaptation leads to later successful integration while early developmental perturbations or deviations may be exaggerated in later development.

A number of developmental meta-theories were previously introduced in respect of typical developmental processes. These theories, enunciated by Piaget, Fodor and Karmiloff-Smith, are prevalent in the developmental literature and influential in contemporary approaches to developmental psychology. Historically, much of the empirical work with atypical populations has adopted a Piagetian perspective, while contemporary theories such as those of Fodor and Karmiloff-Smith present new challenges in studying atypical development. The extent to which each of these theoretical approaches can encompass findings from atypical populations will now be discussed.

All development during the sensorimotor period was domain general according to Piaget thus development of language and social relations are fused with the developing conceptions of space, time and causality. Piaget viewed linguistic development as a product of the emerging symbolic function which develops around 18 months. A delay in sensorimotor development is therefore matched to a delay in the linguistic domain. Piaget's view of development as a domain general process therefore makes it difficult to account for the domains of strength and weaknesses encountered in atypical populations.

Piagetian traditions, with an emphasis on domain general development, are arguably responsible for much of the historical, and somewhat unhelpful, insistence that Down's Syndrome entailed a slowing down of mental development. Classification of children and adults according to sensorimotor stages or mental ages owes much to an insistence on a Piagetian framework for development. In contrast to Piaget's domain general emphasis, Fodor's account of development postulates a number of discrete and independent modules.

Fodor (1989) viewed cognitive development as comprising the development of a number of innately specified input modules each linked to a central system. Recall that input systems have dedicated functional roles, for example within vision at the level of colour perception, shape analysis, face recognition, and in audition, for melody or rhythm detection. It is thus entirely consistent with Fodor's view that advances may occur in one domain, say language, relatively independently of other domains. Furthermore, modules such as grammar could develop independently of lexical, and phonological modules. Fodor's modular view of development neatly accounts for atypical profiles both across and within domains.

Fodor's account of the modularisation of processing tasks does not draw explicitly on data from atypical populations but his suggestions regarding the ontogenesis of input systems implies that input systems could be regarded as deficient in neural architecture and hence function. Fodor does suggest that some functional disorders such as aphasias and anosias occur as a result of the failure of particular input systems and occur independently of the central system. These breakdown patterns are characteristic of the underlying architecture of input systems according to Fodor. Furthermore, Fodor's view that such systems develop under endogenous determination implies that any such deficits are hard wired and innate. While acknowledging that strengths and weaknesses could reflect the relatively poor and relatively superior functioning of particular input systems Fodor also suggests that global deficits in memory or attention processes are possible, presumably as a result of innate central deficits or damage. However, input modules are hypothesised to develop relatively independently under the control of brain maturation and are therefore insensitive to environmental deprivation. Furthermore, Fodor does not specify how development of the central system might proceed in the absence of input from a particular module, say vision or hearing. Fodor's model could certainly account for any domain specific or domain general characteristics of children with Down's Syndrome by appealing to a combined breakdown of input systems and/or central system. However, Fodor's model makes explicit predictions regarding innate specification of input systems and the maturational processes which govern their development - such claims may prove vulnerable to evidence from atypical populations including children with Down's Syndrome.

Karmiloff-Smith's model of representational redescription, or RR, postulates the existence of separable domains of development and some native structure which serves to specify information biases within these domains. The incorporation of domain specificity in the RR model allows for the possibility of uneven cognitive profile in atypical populations. However, Karmiloff-Smith wishes to emphasise the distinction between domain specific information biases and the specification of domains. Fodor's specification of innate modules may only, and only with difficulty, account for development in the absence of a particular module, say in visually impaired children. In contrast, Karmiloff-Smith's model allows for a great deal of plasticity in accounting for atypical populations.

In terms of innate specification of developmental structure and limitations, Karmiloff-Smith's model sits between Piaget's, domain general constructivism and Fodor's nativist and domain specific view of development. Deficits within particular modules are accounted for in Karmiloff-Smith's model as a failure to achieve behavioural mastery and representational redescription within that domain.

1.5 Conclusions

The preceding discussion outlined the central importance of representation as a means of understanding developmental processes and indeed the nature of thought. It is clear that the adoption of a particular view of representation entails fixing its role in thought processes and defining its developmental characteristics. A number of distinct views of representation and the process of representational development in typically developing children have been introduced. Furthermore, theoretical perspectives on representational development have been considered in relation to the development of atypical populations.

Global meta-developmental theories differ widely in their capacity to encompass atypical developmental profiles. Furthermore, these theories make specific predictions about the ways in which anomalies may arise. The striking anomalies present in William's syndrome or in autism are exciting to developmental psychologists wishing to explore representational processes, particularly those involved in the development of language or theory of mind. However, in contrast, children with Down's Syndrome are often characterised as having a coherent, typical developmental profile which is simply a slowed down version of typical development. For this very reason, children with Down's Syndrome have often formed the control group in studies of other atypical populations. In the following chapter, it is argued that development in children with Down's Syndrome challenges our view of typical development in two fundamental ways. First, the characteristic slowing down of development observed in children with Down's Syndrome itself demands an explanation. Second, we argue that children with Down's Syndrome possess a number of characteristic strengths and weaknesses which suggest a departure from the expected developmental coherence.

Chapter 2

Development in Children with Down's Syndrome

The aim of this chapter is to outline the theoretical approaches which are adopted when studying development in children with Down's Syndrome. In the previous chapter, the development of representation was introduced as a way of identifying structural constraints which should, in theory, be applied to typically developing children. In this chapter the development of children with Down's Syndrome is considered in relation to these constraints.

This chapter begins by asking how psychological and developmental processes in children with Down's Syndrome may be similar and different to such processes in typically developing children. One of the traditional arguments surrounds the so called 'delay vs. difference' controversy, i.e. is development in Down's Syndrome delayed or different in comparison to typical development? Evidence is presented both for and against this view of children with Down's Syndrome. The subsequent discussion introduces an alternative view of children with Down's Syndrome and postulates areas of coherence in development, referred to as 'local homologies', while allowing for an uneven developmental profile. This chapter is concluded by drawing the model of local homologies into line with developmental meta-theories some of which incorporate the existence of modules which comprise independent developmental facets.

2.1 Why study children with Down's Syndrome?

Studying children with Down's Syndrome has benefits in terms of an understanding of both children with Down's Syndrome and children without Down's Syndrome. From the viewpoint of children with Down's Syndrome, the intervention process is likely to be more successful if based on a detailed understanding of the atypical developmental processes which are implicated in Down's Syndrome. Furthermore a comprehensive understanding of psychological development would necessarily include an account of development of both typical and atypical populations, thus including children with Down's Syndrome.

Much of the debate surrounding the development of children with Down's Syndrome has focused on what has become known as the 'delay vs. difference controversy' (Hodapp & Zigler, 1990). The controversy concerns the extent to which the development of children with Down's Syndrome can be characterised as different, or simply delayed, with respect to typically developing children. In this section it is argued that both views of children with Down's Syndrome would present challenges for developmental theorists.

To the extent that development in children with Down's Syndrome is uniformly 'delayed' it provides us with a means of carrying out a temporally fine-grained analysis of typical development. A slower rate of development also has a number of implications for examining the contribution of maturational and experiential processes to the timing of developmental transitions. Alternatively, if children with Down's Syndrome can be characterised as being different, they may possess a unique developmental profile. Therefore, just as children with autism provide a means of understanding the relationship between social perception and pretend play, the development of children with Down's Syndrome may also prove to be uniquely informative.

The following discussion considers the global organisation of development in children with Down's Syndrome in comparison to that which is apparent in typically developing children. Subsequently attempts to account for the slower developmental rate in children with Down's Syndrome are considered in contrast to evidence for characteristic strengths, weaknesses, and structural anomalies within this population.

2.2 The organisation of development in children with Down's Syndrome

One dominant theoretical view of children with Down's Syndrome is that development can be broadly summarised as a slowed down version of typical development (e.g. Hodapp & Zigler, 1990). Such a view makes a number of empirical predictions concerning the sequence and structural characteristics which should be conserved in Down's Syndrome as in typical development. In this section we consider the assumptions and predictions which are inherent in this view of children with Down's Syndrome in relation to empirical evidence.

Early views of developmental psychopathology proposed that mental retardation[1] occurred as a result of cognitive 'defects' such as a defect in selective attention (Zeeman & House, 1962), or increased rigidity in general cognition (Lewin, 1935; Kounin, 1948). Zigler's (1969) 'developmental formulation' arose as a reaction to views which proposed defective thinking as a cause of mental retardation. Zigler's view was that retarded children were globally delayed in terms of intellectual development just as someone with an IQ of 100 could be seen as globally delayed in comparison to someone with an IQ of 130. However Zigler's formulation was intended to be applied only to those children who exhibited some form of intellectual impairment without apparent organic aetiology[2] and thus excluding children with Down's Syndrome. Zigler's reasoning was that children without organic aetiology comprised the lower end of the normal distribution of intelligence. Zigler also believed that those individuals at this end of the distribution would follow the same 'universal' pattern in cognitive development as in those of higher IQ but would reach a lower intellectual ceiling. More recently, Zigler's model of delayed

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[1] The notion of a slowing down in development is implicit in the terms 'mental retardation' or 'developmental delay'. However, the use of these terms is not intended to imply acceptance of such views.

[2] These children are termed 'familial retarded' by Zigler (1969) as opposed to those with identifiable organic aetiology,

development has been modified and extended to children with Down's Syndrome (Hodapp & Zigler, 1990; Cicchetti & Beeghly, 1990).

This notion of developmental delay is implicit in the concept of mental age. If ascribing a mental age to an individual is to be meaningful then children of similar mental ages should perform similarly on a wide variety of tests of intellectual ability. Underpinning such a conceptual framework is the premise that there exists a universal sequence and structural properties to development which should be obeyed in children with Down's Syndrome and in typical children. These assumptions are termed the 'similar sequence' and 'similar structure' hypotheses. Such hypotheses are central to the 'organisational perspective' adopted by Cicchetti and Beeghly (1990) and support for these hypotheses is crucial to the view of development in children with Down's Syndrome as globally delayed. In the following section, the evidence for each hypothesis is considered in turn.

2.2.1 The similar sequence and similar structure hypotheses

Children's development has traditionally been considered to comprise a number of discrete developmental domains. It is often implied, for example, that linguistic, sensorimotor, and affective development occur within circumscribed domains. This implication is pervasive in empirical work reported in developmental literature. Development within such domains has consequently been a prevalent focus for attention in studying children with Down's Syndrome. The similar sequence hypothesis implies that children with Down's Syndrome should show the same developmental progression within each domain as that which characterises typically developing children.

There is widespread evidence that the sequential developmental chronology witnessed in typically developing children is broadly maintained within developmental domains in children with Down's Syndrome (Cicchetti and Beeghly, 1990). Within the domain of sensorimotor development (Cicchetti & Mans-Wagener, 1987), the development of smiling and laughter (Cicchetti & Sroufe, 1976), and in the development of play (Hill & McCune-Nicholich, 1981), children with Down's Syndrome follow an apparently typical sequential path. Krakow and Kopp (1983) also offer support for a global delay in cognitive progress within domains of development, 'Delayed young children achieve major milestones in a similar order and with a similar organisation as their normally developing peers, the main reliable differences being that the rate of development is slower and the appearance of achievements is later. This general finding applies to socio-affective development, selective attention, sensorimotor development, language and symbol formation, pretend play, and attachment behaviours' (p.1143). Krakow and Kopp's comments illustrate the widespread support for the similar sequence hypothesis.

The similar sequence hypothesis is broadly supported by empirical evidence. However, sequential development may, by necessity, follow a typical pattern as, for example, children must learn to walk before they can run. Empirical investigations of the similar sequence hypothesis are therefore often implicitly conservative. Recall that the similar structure hypothesis predicts coherence in relationships *between* domains of development. The similar structure hypothesis provides a more crucial test for Cicchetti and Beeghly's 'organisational approach' as there is arguably greater propensity for discrepancies in the structural relationships between domains. Cicchetti and Beeghly (1990) provide evidence for a typical relationship between affective and cognitive development in children with Down's Syndrome. Further evidence for structural coherence is provided by Lenneberg (1966, 1967). Lenneberg reports a similar correspondence between motor and language development in children with Down's Syndrome as that observed in typical development. Lenneberg suggests that such close correspondences between these ostensibly distinct domains implies an underlying structure which is under the control of brain maturation. A study carried out by Butterworth and Cicchetti (1978) compared the development of postural motor control and visual proprioception in a group of children with Down's Syndrome alongside typically developing children. The authors remark that although both groups show similar levels of response to visual stimuli in terms of the frequency of postural adjustment, the magnitude of responses was different in the two groups. Cicchetti and Sroufe (1976, 1978) demonstrated a coherent relationship between affective and cognitive development in children with Down's Syndrome. Children with Down's Syndrome showed a typical pattern in the development of laughter, beginning with responses to simple auditory and visual stimuli, and developing increasing social characteristics. Cicchetti and Beeghly (1990) argue that such results testify to the 'organisation and coherence of early development' (p.55) in children with Down's Syndrome.

Despite the apparent similarity in both structural and sequential aspects of development, developmental, children with Down's Syndrome would certainly appear to develop at a slower rate than typically developing children. It is therefore clear that development in children with Down's Syndrome is different, if only in terms of the rate at which it occurs. As Fowler, Gelman and Gleitman (1994) comment, 'how is it that a child can be learning "normally" over a period of 12 years what is otherwise acquired in 30m.' (p.113). Proponents of the developmental similarity view of children with Down's Syndrome must therefore account for characteristic differences in developmental rate while respecting the global organisation of development. This is rather paradoxical as presumably structural anomalies are likely to be implicated in accounting for the developmental delay. There are many clues to the possible origins of cognitive or maturational limitations to development in its temporal pattern. Alternative views and explanations of this pattern in children with Down's Syndrome are considered in the following section.

2.2.2 The rate of development in children with Down's Syndrome

There is reliable empirical evidence that the developmental rate of children with Down's Syndrome is not only reduced but declines as children get older. Dicks-Mireaux (1972) quantifies this as a decline from an IQ of 75 at 4m to an IQ of 58 at 18m, and other authors have plotted the rate of deceleration well in to adulthood (Zeaman & House, 1962; Carr, 1992). This declining rate of development, while not exclusive to children with Down's Syndrome, is certainly not apparent in typically developing children, and significantly not in 'familial retarded children'[3] (McCall, Appelbaum & Hoggarty, 1973). An explanation of children's failure to maintain a rate of development is therefore warranted.

The temporal pattern of development may suggest particular structural anomalies which correspond either to particular maturational transitions, difficulties with specific levels of cognitive achievement, or simply difficulties with tasks which characterise IQ at particular ages. The subsequent discussion addresses a number of alternative accounts which may allow for a progressive deterioration in developmental rate while maintaining a broadly similar developmental structure.

A number of explanations for the decline in IQ have been suggested, some positing motivational deficits which could have a cumulative effect in impeding learning (e.g. Wishart, 1995), some (e.g. Nadel, 1996) suggesting that differences in neuropathology may constrain the efficacy of children's learning and memory performance, and others (e.g. McCall, Eichorn & Hoggarty, 1977; Kopp & McCall, 1982) suggesting structural limitations which mark the passing of critical periods in development.

A number of authors have pointed to the transitions in typical developmental trajectories which may hold an explanation of the deterioration in the performance of children with Down's Syndrome. McCall, Eichorn and Hoggarty (1977) suggest that children with Down's Syndrome fall behind their peers at a number of transition points, at 2, 8, 13 and 21 months. The authors suggest that these transitions correspond to changes in the characteristics of IQ tasks. Kopp and McCall (1982) argue that children with organic impairments, such as Down's Syndrome have deficits which are founded in the central nervous system and differ qualitatively 'in respect to the density, richness and adaptability of sensorimotor repertoire' (p. 55). The authors suspect the prevalence of immature forms of behaviour in preference to more mature patterns is a result of the organic aetiology and these deficits are particularly noticeable at transition points. Evidence that such transitions

[3] McCall, Appelbaum & Hoggarty, (1973) use the term 'familial retarded children' to refer to children with low IQ in the absence of apparent organic aetiology (cf. Zigler, 1969).

occur is apparent in some large scale growth studies, where each transition is marked by a qualitative change in 'intelligent behaviour'. Kopp and McCall (1982) suggest that it is a limitation in these qualitative shifts which serve to progressively compound the impairment in intellectual development. Kopp and McCall hypothesise that developmental transitions have their roots in neurophysiological organisation. Therefore any anomalies at transition points are interpreted by Kopp and McCall as having a neurophysiological basis.

The neuropathological nature of the learning deficit in children with Down's Syndrome is similarly emphasised by Nadel (1996). Nadel catalogues a number of studies of the early psychological development which may plausibly be linked to neuropathology of the hippocampus and cerebellum such as that found in children with Down's Syndrome from about six months of age. Although many studies of the learning and memory abilities of children with Down's Syndrome show no differences from typically developing infants, Nadel claims that this is a reflection of the limited capacities of all children at this age. As Nadel outlines, structures such as the hippocampus are not fully developed until 16 to 18 months and hence differences would not be evident much before this. This view appears similar to the account of deterioration given by Kopp and McCall (1982). Evidence to support the view that types of learning and memory problems are related to the hippocampus should demonstrate cumulative differences over this period of development. Nadel cites studies carried out by Ohr and Fagen (1993, 1994) which show three-month-olds with Down's Syndrome to have typical learning patterns when leg kicks were reinforced. However, at nine months, children with Down's Syndrome as a group were relatively impaired. Nadel claims that this relative deterioration in children with Down's syndrome is consistent with a hippocampal deficit which develops over the first 18 months of a child's life.

Where such research is useful, as Nadel emphasises, is in identifying how differences in learning and memory may be related to underlying neural dysfunction. Nadel claims that organic aetiology may be responsible for apparent difference in the learning style adopted by children with Down's Syndrome (Wishart, 1993a, 1993b). Wishart (1996a, 1996b) suggests a failure on the part of children with Down's Syndrome to consolidate learned skills, which distinguishes them from typically developing children. Much of this evidence stems from a low test-retest reliability on task performance, a characteristic which has an apparent motivational component. Instability may be seen as a fundamental part of structural reorganisation which is therefore more likely to be in evidence where transitions are made more slowly. However, the instability which has been observed in children with Down's Syndrome appears to exceed the rates one would expect given a protracted transitional period (Dunst, 1990; Shapiro, 1975).

Wishart's view is that instability is characteristic of a general 'approach to learning' in children with Down's Syndrome which acts to shape and limit their learning experiences (Wishart, 1996a, 1996b). Younger children with Down's Syndrome appear to be more passive than typically developing children in a contingency learning paradigm, while older children avoid difficult tasks by 'misusing' social skills (Wishart, 1996a, 1996b; Pitcairn & Wishart, 1994). Pitcairn and Wishart (1994) offer support for this view of children with Down's Syndrome with evidence based on the attempts of children to solve an impossible task. Children with Down's Syndrome appear characteristicallyavoidant and make use of 'party tricks' to distract attention from such tasks.

Differences in the approach to learning adopted by children with Down's Syndrome are also cited by Rast and Meltzoff (1995). Rast and Meltzoff suggest that a 'dampening of epistemic curiosity' is characteristic of the task performance of children with Down's Syndrome. The authors argue that it is 'epistemic curiosity' which drives children to test hypotheses in the absence of external reinforcement. Rast and Meltzoff comment that it is difficult to find tasks which have sufficient 'cognitive capture' to draw in children with Down's Syndrome for cognitive work. Ganniban, Wagner and Cicchetti (1990) also point to motivational differences in addition to attentional patterns which appear to be characteristic of children with Down's Syndrome.

While neurobiological factors such as those identified by Nadel (1996) may correspond to the differences in learning and motivation observed in children with Down's Syndrome few authors explicitly account for motivational differences in these terms. Hodapp and Burack (1990) argue that the declining developmental rate observed in children with Down's Syndrome may arise either from maturational constraints or from a change in task requirements corresponding to attainment of a particular developmental level. These alternatives are illustrated in Figure 2-1 and Figure 2-2. Figure 2-1 represents a decline in rate of development at a specific developmental age. Such a pattern might reflect a limitation in the child's sensorimotor or cognitive repertoire and would be consistent with Kopp and McCall's (1982) account of development in children with Down's Syndrome. Figure 2-2 illustrates a decline in developmental rate at a specific chronological age which would be consistent with a failure of neurobiological maturation if such maturation was mapped onto chronological age. Such maturation constraints at a particular chronological age therefore operate independently of cognitive level.

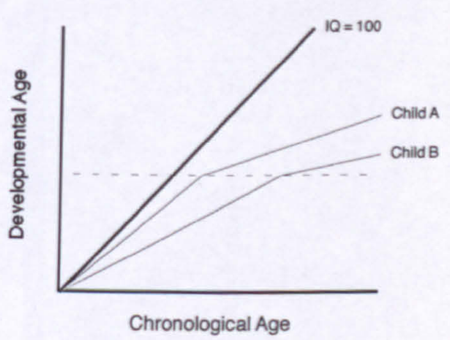


Figure 2-1: Effects of changes in task type on developmental rate

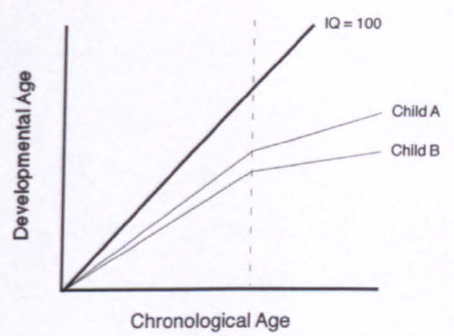


Figure 2-2: Effects of neurobiological structure on developmental rate

Hodapp and Burack distinguish between these distinct developmental growth patterns by appealing to evidence from atypical populations. While children with Down's Syndrome may exhibit rate changes associated with specific developmental ages or stages (Kopp & McCall, 1982), children with Fragile-X syndrome appear to show a decline in developmental rate at puberty, a transition dependent on chronological age. Hodapp and Burack may be right to suggest that the age dependent decline in rate observed in Fragile-

X may be best explained by changes in neurobiological structure, Figure 2-2, but cannot exclude the possibility that similar neurobiological factors might underpin stage dependent changes illustrated Figure 2-1. Evidence for such stage dependent deteriorations may merely indicate that the particular task which delimits IQ at any particular stage requires a neurological feature which is poorly developed.

While it is sometimes assumed that neuropathology is synonymous with an innately specified or purely maturational account, the preceding discussion suggests this is not the case (e.g. Nadel, 1996). Evidence from studies of identical twins with Down's Syndrome suggests a number of phenotypic differences which must be attributed to environmental effects (Shapiro, 1994). Nadel (1996), despite finding evidence for specific cumulative neuropathology in children with Down's Syndrome, is keen to emphasise the possibility that environmental mediation could ameliorate the deficit. Indeed Nadel views his account of development as entirely consistent with the motivational account proposed by Wishart (1993b).

A number of global differences in both motivation and learning in children with Down's Syndrome have been outlined in this section. Such evidence serves as a means of resolving the paradox inherent in the delay account of development. The paradox is essentially that the delay is itself a structural *difference* and cannot be accounted for within the 'delay' standpoint. Resolution of this paradox may require nothing more than a shift of emphasis or change of terminology. Cicchetti and Beeghly (1990) resolve the problem of terminology by using the term 'organisational' perspective to refer to the broadly typical pattern of development of children with Down's Syndrome. The organisational perspective therefore maintains that children with Down's Syndrome develop in a similar structural and sequential manner to that observed in typically developing children. Furthermore, the existence of anomalies serves to illustrate alternative ontogenetic pathways. Thus, according to Cicchetti and Beeghly (1990), accounts of global deficit in learning and motivation do not threaten the structural integrity and organisation of development in children with Down's Syndrome.

However, in the following section, the evidence for this 'organisational' view and complementary accounts for a global delay are contrasted with evidence for the emergence of particular developmental strengths and weaknesses in children with Down's Syndrome. The question which needs to be addressed is whether such strengths and weakness can be reconciled with the view of children with Down's Syndrome as organisationallycoherent?

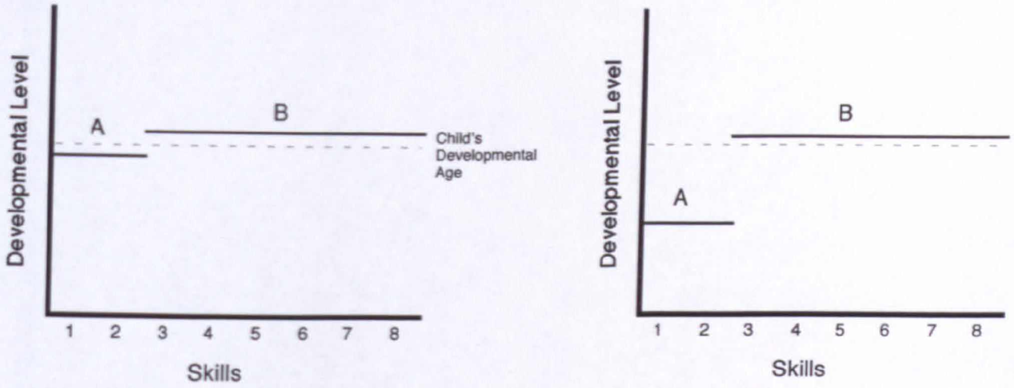
2.2.3 Developmental differences: strengths and weaknesses

The evidence presented above (section 2.2.1) suggests a broad correspondence between development in children with Down's Syndrome and typically developing children. Furthermore, evidence suggests that the organisation of development is similar in terms of sequential progress within domains and structural relationships between domains. However, there is widespread evidence to suggest that children with Down's Syndrome do have characteristicstrengths and weaknesses when compared to typically developing children at a similar level of cognitive development. Such strengths and weaknesses challenge the view of children with Down's Syndrome as globally delayed and structurally coherent in developmental terms. One notable weakness is in language development (Fowler, Gelman & Gleitman, 1994) whist social development appears to be a relative strength (e.g. Gibbs & Thorpe, 1983; Centerwell & Centerwell, 1960). The methodology of the studies underlying these claims is based upon the premise that children of similar mental age should perform similarly on a number of specific tasks. Typically developing children certainly have strengths and weaknesses relative to each other, but researchers in the field of Down's Syndrome are seeking to identify consistent strengths and weakness which may be attributed to the syndrome itself.

A number of studies report a delay in linguistic development in children with Down's Syndrome relative to other skills (e.g. Mahoney, Glover & Finger, 1981; Leifer & Lewis, 1984; Cardoso-Martins, Mervis & Mervis, 1985). Mahoney, Glover and Finger (1981) report a delay in linguistic development relative to sensorimotor development with lexical acquisition lagging behind performance on means-ends and object permanence tasks. Cardoso-Martins et al. (1985) report similar findings. Within the domain of language development, children with Down's Syndrome appear to be particularly delayed in grammatical development (Leifer & Lewis, 1984). Leifer and Lewis compared children with Down's Syndrome matched with typically developing children on the basis of mean length of utterance, or MLU, a measure of the grammatical complexity of children's speech. The pattern of results suggests that children with Down's Syndrome were more advanced than the typical group on 'social' aspects of conversations, turn-taking and responding appropriately to questions. In contrast, the levels of grammatical complexity of children's spontaneous utterances were well behind typically developing children matched for developmental age.

Children with Down's Syndrome have been characterised, somewhat stereotypically, as being sociable (Gibbs & Thorpe, 1983) and the performance of children with Down's Syndrome on a number of social measures is relatively advanced. The strength of social development in children with Down's Syndrome was the focus of a study carried out by Centerwell and Centerwell (1960) who reported a wide discrepancy between IQ scores as measured by the Stanford Binet test, and Social Quotient scores, SQ, as measured by the Vineland adaptive behaviour scales. A number of other studies also report that children with Down's Syndrome have relatively advanced social skills evident in play (Landry & Chapieski, 1990) and pragmatic skills (Leifer & Lewis, 1984).

Despite the evidence for particular strengths and weaknesses within social and linguistic domains respectively, it would not be fair to conclude that development within children with Down's Syndrome is structurally disorganised. Evidence presented earlier suggests a surprising degree of structural coherence between particular domains. Mundy, Seibert and Hogan (1984) suggest that a model of development based on the existence of *local homologies* may provide a means of reconciling potentially conflicting empirical evidence regarding the structural integrity of development in children with Down's Syndrome. The model suggested by Mundy, Seibert and Hogan, groups together skills which show strong inter-correlations into distinct homologies while skills which are not inter-correlated reside in distinct structural domains. The model is represented pictorially in Figure 2-3.



Local homologies for NDS children

Local homologies for DS children

Figure 2-3: Model of local homologies for Down's Syndrome and typically developing children (adapted from Hodapp & Zigler, 1990)

The model provides a clear descriptive account of empirical evidence from children with Down's Syndrome in relation to evidence from typically developing children. For example, skills 1 and 2 are seen as causally related in typically developing children and form components of a local homology, A. In the model of children with Down's Syndrome, homology A is globally delayed preserving the structural relationship between component skills 1 and 2. In contrast, skills 1 and 4, while correlated in typically developing children, do not share a causal structural basis and are represented as components in separate homologies, A and B. The discrepancy between these skills in children with Down's Syndrome merely illustrates a structural independence which is present, but not apparent in typically developing children.

The model of development suggested by Hodapp and Zigler is consistent with Cicchetti and Beeghly's view of development in children with Down's Syndrome but also illustrates the same circularity in its approach. Both Hodapp and Zigler (1990), and Cicchetti and Beeghly's (1990) organisational perspective, suggest that violations of the structural integrity observed in typically developing children merely serve to illustrate ontogenic possibilities which are not apparent in typically developing children. This 'organisational' perspective does not imply that there are no discrepancies between domains of development, as Cicchetti and Beeghly are keen to emphasise. However, the authors argue that where discrepancies exist one might also expect to find discrepancies within the typically developing population. Indeed, a fundamental justification for the empirical study of children with Down's Syndrome, according to Cicchetti and Beeghly, is to elucidate where structural relationships are logically necessary and where alternative pathways of ontogenesis are possible. Cicchetti and Beeghly argue that the delayed pace of development, prolonged developmental transitions and variability between developmental domains make the elucidation of sensitive periods in ontogenesis possible.

It is in this respect that Cicchetti and Beeghly's argument seems rather circular. When children with Down's Syndrome observe typical structural patterns this is seen as reinforcing the typical view of developmental organisation. In contrast, deviations are seen as illustrating alternative ontogenetic pathways which are prevalent in, but not evident in, the typically developing population.

It is possible that Cicchetti and Beeghly may be right, however it is also possible, indeed plausible, that the ontogenetic pathway followed by children with Down's Syndrome is atypical. Deviations from typically developmental pathway may or may not be within the bounds of typical variation, but in either case may correspond with developmental psychopathology. It is clear, therefore, that any structural anomalies which appear to be exclusive to, or more prevalent in, children with Down's Syndrome warrant investigation.

The importance of considering potentially pathological developmental processes reflects the need to account for apparent developmental limitations in children with Down's Syndrome. A discrepancy between skills could thus serve to illustrate a violation of typical structural integrity in children with Down's Syndrome where such skills are structurally linked in typically developing children. For example, in the model illustrated in Figure 2-3, skills 5 and 8 are components of a single structural homology in typically developing children but are distinguished in children with Down's Syndrome as a result of a breach in the structural homogeneity of homology B. While Cicchetti and Beeghly argue that this discrepancy serves to illustrate the existence of two homologies which are indistinguishable in typically developing children, it is argued here that a structural violation within a homology is also worthy of consideration.

Evidence from a range of empirical studies thus demonstrates both a degree of structural integrity and potential structural anomalies in children with Down's Syndrome with respect to typically developing children. While evidence for structural integrity is based on a similar profile of development with respect to typical development, anomalies are outlined by strengths and weaknesses with respect to this population. The interpretation of anomalies in atypical populations is heavily dependent upon evidence for a structural relationship between domains existing within the typically developing population. However, evidence provided by inter-correlations between facets or domains of development is clearly insufficient as the sole basis for establishing the structural continuity in the typically developing population. The interpretation of anomalies in children with Down's Syndrome as either benign or pathological requires an understanding of causal relationships within the typically developing population. What is lacking here is a theoretically-driven approach to establish where causal relationships exist i.e. where the homologies should be, both in typically developing children, and in children with Down's Syndrome.

2.3 Discussion

This chapter began by stressing the mutual benefits to be gained from studying typical development in relation to atypical development and to Down's Syndrome in particular. It is by studying the development of children from atypical populations that one can distinguish true developmental convergences from coincidence in typical development. However it is clear that notwithstanding the inherent value of developmental data from children with Down's Syndrome, advancing the model of typical development has implicit benefits for these children. Our current interventions serve to reinforce a developmental chronology based on typically developing children. If this chronology, in the light of comparative evidence from children with Down's Syndrome, turns out to be rather more coincidental than interdependent, then our intervention strategy can be radically reformed.

Studying the development of children with Down's Syndrome allows us to investigate the constraints which innate predispositions, and environmental factors, place on children's development. The notion of children as subject to a developmental delay immediately implies a discrepancy between processes governed by maturation and processes dependent on learning. However, the 'delay' approach to children with Down's Syndrome fails to address the discrepancies between domains of development, and not least, the progressive decline in developmental rate. It is argued that children with Down's Syndrome do have specific strengths and weaknesses which suggest either anomalous structural limitations or different ontogenetic pathways. However, the theoretical perspective adopted by Cicchetti and Beeghly (1990) fails to address the possibility that anomalies apparent in the development of children with Down's Syndrome may be atypical and/or pathological.

Establishing the extent of continuity or discontinuity between the developmental processes evident in children with Down's Syndrome and typically developing children demands a theoretical framework to determine where causal relationships and developmental homologies should exist. A theoretical framework could therefore establish the basis for structural relationships between skills which can then be used to interpret empirical evidence from the Down's Syndrome population. Theoretical models of development, such as those of Piaget (1953/1970) and more recent views such as those of Karmiloff-Smith (1992/1995) and Fodor (1983) do make testable empirical predictions about development and the structural constraints which should apply. Furthermore, existing data on the development of children with Down's Syndrome suggest particular areas in which theories of meta-developmental processes may be vulnerable.

Perhaps not surprisingly, much of the emphasis in empirical studies of global development in children with Down's Syndrome have addressed a Piagetian framework. The extent to which children with Down's Syndrome traverse the developmental stages in the same sequence as typical development and respect the structural relationships between domains, as proposed by Piaget, is surprisingly supportive of a global delay across the board. Other studies carried out within circumscribed domains of development such as language, social development or cognitive development may provide evidence of structural integrity in the development of children with Down's Syndrome. Cicchetti and Beeghly offer support for a global delay in postulating the link between affective and sensorimotor development. However the empirical methodology adopted in such studies often presupposes a Piagetian framework for development, or that domains such as 'language' have theoretical validity. In the light of such conservative empirical constraints it is not surprising therefore that results often support the existence of such domains.

In the previous chapter it was argued that theories of representational development constrain the relationships between developmental domains, or modules, and predict the nature of the developmental process itself. Meta-developmental theories make claims regarding the role of innate constraints, maturational processes, and environmental influences in development. Such claims allow us to make testable empirical distinctions between competing theoretical approaches to development.

Our theoretical views about the underlying global structure in developmental processes are changing. Our ideas about what may constitute a developmental 'domain' are also in a state of flux. Therefore, if links are to be identified between domains of development they may as well be found between working memory and grammatical development as between lexical and syntactic domains. However, many of the domains which have been the focus of past efforts do not coincide with vulnerable fracture points in contemporary views of development. Contemporary alternatives to the Piagetian view of development offer challenges which need to be met within studies of atypical populations as well as within typical development. Subsequent chapters set out the relationship between domains of representational development in the light of contemporary developmental theory and attempt to review evidence from existing literature with reference to such theoretical shifts.

In summary, the following discussion and empirical work is aimed at understanding the processes implicated in the development of children with Down's Syndrome. In contrasting these processes with those at play in typically developing children, we hope to understand how the environment might be adapted to suit the particular needs of children with Down's Syndrome.

Chapter 3

The Development of Representation: Object Permanence

The previous two chapters outlined the importance of having a theoretical basis to guide the interpretation of empirical data from children with Down's Syndrome. Furthermore, it was argued that a representation-focused account of development in infancy is best placed to examine the constraints which guide development within and between domains. This chapter introduces one of the central theoretical concerns of developmental psychology, the representational status of object permanence. Object permanence is a central feature of the Piagetian view of development in infancy. As was argued in chapter two, much of the evidence on the development of children with Down's Syndrome stems from this Piagetian framework. A discussion of object permanence is therefore pertinent both to a representational view of development and the particularly the development of children with Down's Syndrome.

The status of object permanence in determining the child's representational capability owes much to Piaget (1955/1976). Piaget believed that children's representational sophistication was reflected in their ability to search for objects. This chapter begins by presenting an overview of Piaget's account of representational development in typically developing children. Recent evidence which casts doubt on Piaget's unitary view of representational development and alternative views are also presented. This chapter concludes with evidence from children with Down's Syndrome. It is argued that the anomalous cognitive profile in children with Down's Syndrome may impinge upon object permanence development and performance on object permanence tasks. A representational account of the development of object permanence in children with Down's Syndrome is introduced.

3.1 The development of object permanence in typically developing children

Piaget believed that the child's concept of object permanence reflects an emerging representational capacity. Consequently, children's search errors expose the immaturity of their representational systems. Piaget believed that children acquired adequate conceptions of reality through experience of their own actions and consequent structural reorganisation of internal representations. While initially, children's behaviour is based entirely on what Piaget referred to as 'action schemes', later performance is mediated by internal, mental representation. It is the gradual transition from sensorimotor action to representational thought which is reflected in search and driven by the child's experience of action.

Piaget suggested that the child's concept of the nature of objects, 'object permanence', could be seen as comprising several facets which develop in parallel during the period of sensorimotor development (0-18m). Piaget considered working cognitive models of causality, space and time to be fundamental to children's understanding of objects. According to Piaget, children under nine months of age fail to search for hidden objects because they effectively cease to exist for them. When children do begin to search for hidden objects they will only do so in a restricted set of circumstances. Initially, at stage III (six to eight months of age), children will only successfully retrieve an object if they initiate a reaching action before the object is covered. Thus, children at stage III can only 'represent' hidden objects having initiated a reaching action to a perceived object. Children who reach stage IV, at eight to nine months, are then able to represent hidden objects but again their representation is based on action and is essentially egocentric, 'objects are where I look for them'. Having mastered searching for an object at a single location, the child fails to take account of a change of hiding place, returning instead to the previous location. This error pattern is characteristic of stage IV and is commonly referred to as the *A-not-B error*. 'A-not-B' refers to the fact that a child, following successful search at location A, does not successfully retrieve the object from its second hiding place, location B. Children at this stage simply repeat their sensorimotor schema to recover hidden objects and therefore fail to take account of a change in hiding place leading to the A-not-B error.

The transition from stage IV to stage V marks a decline in egocentricity and allows the child to take account of a sequence of displacements in a multiple location search paradigm. Following success at this stage children have difficulty in searching for an object if they cannot see it being moved to its hidden location, an invisible displacement. Invisible displacement typically involves the experimenter hiding a small object in her hand and then leaving the object behind a cloth or screen such that the child does not see the object disappearing behind the occluder. It is not until late stage V that children appear able to infer the object's true location. Later, children's representational capacity allows them to draw inferences about an object's location which are free from action schema, so that, during stage V, children are able to solve invisible displacements by constructing a mental representation of the hidden object. However, Piaget argues that at this stage the child is unable to solve tasks involving invisible displacement through more than one location. The child therefore makes the A-not-B error when invisible displacements are involved. The child must therefore relearn a solution to sequential displacement on the plane of representation rather than sensorimotor action. The final stage of object permanence development involves mastery of serial invisible displacement in which the object, hidden in the adult's hand, is passed through a series of possible hiding places before finally being hidden. Prior to stage VI, children witnessing a serial invisible displacement tend only to search in the first location in the series rather than searching exhaustively through all possible locations.

The empirical data on which Piaget based his views of representational development has proved to be surprisingly reliable and has been replicated in a number of studies (Uzgiris & Hunt, 1975; Corman & Escalona, 1969). Contemporary objections to Piaget's views are directed at his interpretation of the data in representational terms. Before presenting these objections, it is necessary to present a detailed description of the Piagetian account of representation and object permanence.

3.1.1 The Piagetian view of representation and object permanence

Piaget discusses the child's developing construction of reality as comprising several components; object concept, spatial field (groups of displacements), causality, and the temporal field. While these components of understanding were seen as structurally interdependent, Piaget believed that search errors reveal particular features specific to each domain.

In developing an object concept a child gains an increasing knowledge of an object's permanence as distinct from sensorimotor action. The end of the sensorimotor period marks the beginning of the capacity to represent objects mentally. The progression in a child's reaction to hidden objects reflects a stagewise emergence of representational capacity.

Within the domain of spatial understanding, Piaget hypothesised that the child's sensorimotor experience was reflected in implicit understanding of an increasingly complex group of displacements. The notion of a developing spatial field has been characterised as the development of objectivity vs. subjectivity and the decline of egocentricism. The transition in terms of groups of displacements is therefore from a subjective to an objective sense of displacements, and finally to a representation of space. This progression allows the child to dissociate retrieval actions from ego-spatial locations.

The development of causality is a further component to which Piaget attributes search errors. As late as stage III, according to Piaget, the child's understanding of causality is 'magico-phenomenalist' and the child sees external causes and effects as distinct, unrelated elements. In relation to object search, external causes of disappearance remain subordinate to the child's own activity. Through stages IV and V the child's understanding of causality becomes increasingly objective, encompassing external causes, and a spatial component.

In terms of development within the temporal domain, the child's understanding of 'before' and 'after' is yoked to her own actions. 'Before' and 'after' are therefore subjective concepts which have no direct bearing on external events. The child makes the A-not-B error in temporal terms because of an inability to conceptualise the temporal sequence of displacements. On reaching stage V, children are able to arrange external events in temporal order and by stage VI they can evoke memories of such action.

While Piaget discusses the emergent conceptualisation of objects, time, space, and causality as components, the understanding of each is mediated by the child's transition from subjective to objective viewpoint. The child therefore makes the A-not-B error on the basis of a number of interrelated physical misconceptions i.e. the child fails to understand the spatial and temporal components of the displacement caused by an external agent.

3.1.2 Non-search studies of object permanence

Over the past fifteen years accumulating evidence based on new paradigms for studying children's representational ability suggests that infants may have an early conception of physical properties and the behaviour of objects well before they begin to search for hidden objects. This evidence challenges the Piagetian view that the child's failure to search reflects a failure to maintain a representation of an object.

3.1.2.1 Do children have representations of objects prior to searching for them?

New-born infants appear to have a number of perceptual abilities relating to the form and spatial properties of objects prior to experience of reaching for objects at around 4.5 months. Children appear to be able to detect changes in the shape and form of objects from as young as two days old (Slater & Morrison, 1985; Slater, Mattock & Brown, 1990). Children also appear to detect changes in distance of a looming object (Ball & Tronick, 1971). However, the claim that infants are able to detect absolute 'distance' is controversial (Bremner, 1989). Such information is unlikely to be based on experience of reaching to distant objects which does not begin until around 4m.

Additional evidence from Kellman and Spelke (1983) suggests that children of four months can use the properties of moving object to draw conclusions about the form of hidden elements. Spelke suggest that a child's perception of partially occluded moving objects is covered by principles of boundedness, cohesion, rigidity and 'no action at a distance' (Spelke, 1988; 1990). Further recent evidence has suggested that such principles are not operative at birth (Slater, Morrison, Somers, Mattock, Brown & Taylor, 1990) but the authors do not rule out the possibility that these principles are innately specified.

Spelke, Breinlinger, Macomber, and Jacobson (1992) present evidence from a further dishabitutation study which suggests that children are sensitive to principles of gravity and solidity of surfaces. Children as young as four months dishabituated to the motion of an object through a surface and at six months to events which involved an object suspended without support. Spelke suggests that an infant's knowledge of physical principles such as these, while not present at birth, is guided by innately specified mechanisms which require minimal direct experience with objects. Spelke's views stand in contrast to those of Piaget.

3.1.2.2 Do children have representations of hidden objects prior to searching for them?

While Spelke's experiments suggest some knowledge about the properties of visible or partially occluded objects, much of the Piagetian framework is based on children's reactions to hidden objects. The use of search behaviour as a criterion for representation may be over conservative. Infant's failure to search may not indicate a lack of representation but a lack of motor ability or means-end abilities to effectively recover the object. The work of Baillargeon (1986, 1987a, 1987b, 1991) suggests that infants at three to four months old do have some awareness of the properties of objects when hidden. Baillargeon's drawbridge experiment demonstrates that infants will dishabituate to the movement of a rotating drawbridge through the path of a hidden object. Children dishabituate to this 'impossible event' despite being unable to see the object which should impede the drawbridge's progress. Further evidence of a reaction to hidden objects comes from Baillargeon and DeVos (1991). Baillargeon and DeVos report that children anticipate the appearance of a tall carrot passing a window in a screen but not the appearance of a shorter object. This study therefore demonstrates that children are maintaining not only the representation of a hidden object but represent some of its physical properties, in this case its height.

With regard to children's knowledge of retrieval actions, Baillargeon, Graber and DeVos (1990) showed that five month old infants distinguish between possible and impossible retrieval events. The evidence for this is based on infants' increased dishabituation to impossible retrieval actions in which an object is retrieved from behind a blocking barrier.

Baillargeon et al. argue that these results imply that infants have knowledge of the properties of hidden objects despite failing a standard Piagetian search task. Given that children appear to have knowledge of hidden objects we need to ascertain the extent to which this knowledge constitutes representation. Furthermore, if children appear to recognise successful search strategies, how can we explain their failure to search? The extent to which children's 'knowledge' is equivalent to representation is discussed later in this chapter (section 3.1.2.4). In the following section explanations for a failure to search are discussed.

3.1.2.3 How do we account for failure to search?

Evidence from Hood and Willatts (1986) suggests that children are able to successfully reach for objects 'hidden' in the dark. How can this apparent capacity to execute the correct search behaviour in response to hiding be reconciled with children's failure to search under standard conditions.

Baillargeon, Graber, DeVos and Black (1990) argue that before eight months of age, children have an executive difficulty which places limitations on their ability to plan. They argue that retrieval of a hidden object involves non goal-directed action i.e. the removal of an occluder, in order to retrieve the object. The conflict between the goal of object retrieval and the action to remove the occluder are beyond the planning capacity of an infant before eight months of age. Baillargeon et al. therefore suggest an information processing deficit in which a lack of executive capacity masks infants knowledge about the objects location.

In contrast to Baillargeon et al.'s account, a competence explanation for children's failure to search is offered by Russell (1996). Russell argues that infants fail to understand what they have to do. They cannot conceive of how 'their visual experiences are a function of what they can do' and cannot therefore plan manipulations of the visual environment on the basis of their action. Russell's explanation is equivalent to a deficit in agency, in which the infant is not sufficiently aware of the capacity his actions have. Other researchers have pointed to the fact that most non-search studies require a response within the visual array to a visual event. Diamond (1985) argues that search actions are limited by a delay in myelination of the prefrontal cortex. Translations of visual information into motor action therefore require cortical mechanisms which are not available to children before nine months. This explanation is supported by data from rhesus monkeys and macaques which shows a peak of synaptogenesis coinciding with stagewise transitions in cognitive capacities (Fischer, 1987). Fischer suggests that a similar process may be observed in human synaptogenesis in infancy and is supported by evidence from physiological measurements.

3.1.2.4 What remains of the 'object permanence' concept?

The identification of awareness of hidden objects prior to search also poses a problem of how to define the representation of an object. Baillargeon's experiments appear to suggest the existence of sophisticated representations of objects prior to search. Is an enduring representation of a hidden object a sufficient condition for 'object permanence'? Alternatively, is a more conservative, search dependent definition required? Russell (1996) makes the distinction between 'representation permanence' in the case of the dishabituation studies and 'object permanence' for children who can execute effective object retrieval. Information theorists, according to Russell, argue that representation permanence = object permanence. However, Russell argues that maintaining a representation of an object does not mean 'knowing it exists'. Knowing an object exists requires knowing the relationship between that object and oneself. The distinction which should be drawn, according to Russell, is one of *externality*. Externality requires knowing 'something about the relation between oneself as a spatially located experiencer and the object as the cause or possible cause of one's experience' (p. 113). Russell (1996) draws support from studies of 'transitional search' behaviour in which children at stage III appear to execute the appropriate retrieval action but appear not to understand what they have done (Willatts, 1984). Such children may lift a cloth under which a toy had been hidden but subsequently, ignore the toy and play with the cloth instead. Such behaviour supports the Piagetian view that children at stage III may have some representation of a hidden object but this representation is not equivalent to knowing where the object is.

While Russell (1996) appears to be suggesting a clear distinction between maintaining a representation of a hidden object and executing a retrieval action, Munakata, McClelland, Johnson and Siegler (1994) suggest a gradualistic approach to children's representational development in this domain. Munakata et al. trained seven month olds to retrieve an object placed at a distance by either pulling a towel or pressing a button. Subsequently, either a transparent or an opaque screen was placed between the child and the object. Children were able to recover the object in the transparent condition but not with the opaque screen. Munakata et al. claim that these results support a graded view of representational development in which weaker representations are sufficient to drive simple output, such as eye movements, but stronger representations are required to initiate complex means-ends behaviour.

Karmiloff-Smith (1992/1995) offers a comparable synthesis of dishabituation and search data in terms of representational redescription. Responses in dishabituation studies may be a reflection of 'Level I' implicit representations. Such representations may not therefore be accessible to processes which govern retrieval. Later, children's manual search is based on higher order, explicit, representations. In these terms, children's early dishabituation responses, based on implicit representations, are not conceptual or theory like, but the child focuses on external data to create 'representational adjunctions'. Representational adjunctions are simply added to children's existing stock of data and do not alter existing representations.

Despite the controversial claims surrounding the nature of children's representations prior to searching for hidden objects, children at stage IV continue to make search errors which say something about the nature of emerging representations. While from 8 to 12 months the ability to search at a single location for a hidden object becomes well established, children make a characteristic mistake when the object is transferred to a second location, the A-not-B error.

3.1.2.5 Explanations of the A-not-B error

The A-not-B error is characteristic of children's search between 8 and 12 months which corresponds with stage IV of sensorimotor development. The error arises when, following search at one location (A), the object is subsequently hidden at a second location (B). Children fail to redirect their search behaviour and tend to return to location A. The Piagetian explanation of the A-not-B error is that it is the result of an egocentric spatial code. In Piagetian terms, children at stage IV believe that an object's existence is dependent on action, and children believe that 'objects are where I choose to look for them'. Bremner and Bryant's (1977) study demonstrated that infants do appear to use an egocentric or 'self-referential' code in performing the two location search task. Bremner and Bryant argue that the standard A-B task confounds both self-referential and external reference systems and carried out a study in which the infant was moved between successive hidings of the object. They report that performance on the AB task was consistent with a self-referential coding of spatial relationships. However, children did appear to use an allocentric code if the locations were made distinct using different coloured covers (Bremner, 1989). These results suggest that the infants were only using egocentric references in the absence of salient allocentric cues.

A number of modifications of the standard A-B task have led to alternative explanations of this particular error. Bjork and Cummings (1984) argued that the standard A-B task only allows one alternative to correct search and hence the only possible error is the perseverative or egocentric one. Bjork and Cummings used a series of five wells and found that 80% of errors were closest to the correct well rather than the well where the object was previously hidden. Bjork and Cummings argue that this error pattern is not consistent with an explanation of egocentric spatial coding but may be a memory effect. The memory explanation is supported by Bjork and Cummings' evidence that errors become increasingly likely with a longer delay between hiding and retrieval. However, an explanation based on poor memory is undermined by evidence that children will search at the wrong location even when the object is visible (Harris, 1974). Consistent with both Bjork and Cummings', and Harris' data, is Diamond's (1985) account of a failure to inhibit a previously successful search response. Failure to inhibit the previously successful response results in a reach towards location A when the object is transferred to location B (Diamond, 1985). While a memory explanation would require errors to deteriorate over time from correct responding to chance performance, Diamond's 'memory+inhibition' account predicts a developmental progression from correct to incorrect, and subsequently to chance performance. Furthermore, errors due to a perseverative reaching should be closer to well A than to well B, while memory failures should be closer to well B. Diamond (1985) argues that the arrangement of the hiding locations in the Bjork and Cummings study cannot distinguish between memory and inhibition accounts of search failure. Diamond, Cruttenden, and Niederman (1994) present evidence from a multiple-well study in which errors due to memory would be either side of the B location while failure to inhibit a previous response should result in more frequent errors towards location A. Diamond et al. find precisely this pattern and suggest a memory and inhibition account of children's A-not-B errors. The suggestion that both memory and inhibition are involved in the A-not-B error is consistent with neuropsychological models which implicate the frontal lobe in the inhibitory control of action. Diamond's view of the A-not-B error is supported with evidence from primates with frontal lesions and human patients with frontal lobe damage who make errors similar to children of nine to 12 months. Furthermore, developmental progression during this period correlates with development of the prefrontal cortex.

In summary, studies suggest that performance on the A-B task is not limited by representational development. Such studies explain the A-not-B error as an information processing limitation rather than a representational competence deficit. Both memory and memory+inhibition accounts of failure suggest that it is a deficit in information processing rather than underlying representational problems which results in the error. Piaget's explanation of the A-not-B error, while offering similar empirical predictions to Diamond, is as a deficit of competence in which inadequately structured representations lead to error. However, just as was the case with children's errors at stage III, there is evidence to suggest that children hold a veridical representation of the object's location and have the means-ends capacity to solve the problem while making errors on the A-B task.

Baillargeon and Grabber (1988) demonstrated that children at eight months dishabituated to visual displays showing an A-not-B error as compared to a correct retrieval in the two location task. Other studies have shown similar discrepancies between visual responses and manual search. Diamond (1991) presents evidence that children often look at the correct location B while searching at A and making the A-not-B error. Gilmore and Johnson (1995) found that children appear to respond correctly when making visual saccades to an object's location. Such findings, which show a preference for the visual modality in solving the AB problem, are reminiscent of children's performance at stage III. Similar explanations can be offered for this discrepancy. Firstly, the means-ends demands of manual action are likely to be greater in the manual response condition and information processing errors are exaggerated (Gilmore & Johnson, 1995). Secondly, maturational development of cortical structures may limit the capacity for a manual as opposed to a visual response (Diamond, 1995). Both explanations, as was the case at stage III, cite the preference for a visual response over manual action.

3.1.3 Summary

The Piagetian view of developments cites inadequate representations as the primary cause of children's failure to search for objects prior to eight months of age. More recent evidence suggests however that children younger than eight months have sophisticated knowledge of hidden objects and forces us to re-examine traditional explanations of failure to search (Baillargeon et al., 1990; Spelke, 1988; 1990). Furthermore, the existence of some demonstrable knowledge of hidden objects requires a reinterpretation of the theoretical and empirical basis which defines representation.

Explanations of failure to search at stage III and the A-not-B error at stage IV have cited some form of limitation on manual responses imposed by neurological structure or information processing capacity. However, there is growing evidence to suggest that these limitations can be ameliorated by increasing the salience of the initial representation. While the effect of a reduction in delay, and potentially a reduction in the salience of the prepotent response, would support memory and inhibition explanations respectively, other empirical findings lend themselves to a representational salience account. Wellman, Cross and Bartsch (1987) report advantages in increasing the distance between the successive hiding locations, and salience of the distinction between locations. Such evidence is in conflict with an all or nothing account of object representations but supports a gradualistic view of representational development.

In relation to the A-not-B error, Harris (1974) showed that infants still make the error when transparent perspex covers are used and the object therefore remains visible at B. However, Yates and Bremner (1988) have argued that children's lack of familiarity with perspex may be impeding their performance in this task. Once familiarised with the perspex covers, children do not appear to make the A-not-B error. Prior experience with perspex could be seen as reducing its inherent salience and thereby increasing the relative salience of the visible object. Despite the apparent conflict in these data it is clear that the salience of the object's locations can have an effect on children's ability to overcome the perseverative response. A similar explanation could explain Bremner's finding that children do appear able to use an allocentric code when hiding locations are distinguishable (Bremner, 1989).

In recognition of the dual role of representational 'strength' and means-ends demands, Munakata, McClelland, Johnson, and Siegler (1994) present a 'gradualistic framework' for understanding infants successes and failures in object permanence tasks. Munakata et al. argue that in their task, the means-ends demand was identical with both transparent and opaque occluders but objects were only successfully retrieved in the transparent condition. Munakata et al. claim that this pattern of results is explained in terms of the relative strength of representation and demands of retrieval. The representational strength must be sufficient to exceed the threshold for retrieval. Lower level occular responses can, in contrast to motor solutions, be driven by weaker representations. Such a model could equally be applied to the contributions of representational strength and information processing limitations in infants' A-not-B errors.

Further evidence suggests that the child's representation of the object may not be the sole cue to the object's location. Diamond et al. (1994) note a difficulty in covering hiding locations in multiple-well conditions in that children can use the action of covering a well as a cue to the object's location. Harris (1973) found that infants are more likely to be successful if the last location to be concealed is also the correct location. Similarly children's ambivalent reactions to found objects suggest a low expectation of finding something. Willatts (1984) commented that it is the action of hiding which 'calls out the familiar procedure of lifting' rather than a desire to recover the object.

Infants may use other cues which are inherent in the hiding action as a means of guiding retrieval. Fischer and Jennings (1981) draw attention to the role of children's understanding of agency as a potential aid in solving object permanence tasks. Fischer and Jennings argue that Piaget's emphasis on the object has lead to 'neglect of the agent' in object permanence tasks (Bertenthal & Fischer, 1983). The authors argue that representations of the experimenter as an agent in hiding tasks could serve as a cue to the location of the object. Fischer and Jennings hypothesise that anomalous results on the performance of children on stage VI tasks could be explained by children's use of representations of the hiding action in addition to representations of the hidden object. Fischer and Jennings do not wish to imply that children do not represent the object in such tasks, merely that the representation of the experimenter as an independent agent could prove a valuable additional cue. In the case of the standard stage VI search task, infants may make use of the rule that the object is hidden at the last location touched by the experimenter.

It is clear that search behaviour is neither limited by children's 'all or nothing' representational capacity nor necessarily (i.e. not always) by limitations on processing capacity. Children's performance can be improved in a number of ways which increase the salience of the representation or reduce the information processing demands. Correct responses are more likely if the memory trace is stronger (via a reduction in search delay), or a prepotent response is more salient (object is visible at A). Information processing demands can be reduced by allowing occular responses as an indication of 'knowledge'. Later, as children become aware of the agency of others, they are able to use cues provided by the action of hiding as a means of solving object permanence tasks. The tasks used to asses object permanence clearly span a number of cognitive and social components. If object permanence is to be defined by the tasks used to measure it, then 'object permanence' may not be a unitary representational domain. Some children, particularly those with atypical developmental profiles, may have a unique blend of 'object permanence' skills and may therefore proffer atypical solutions to object permanence tasks.

3.2 The development of object permanence in children with Down's Syndrome

The centrality of object permanence as indicating the representational status of infants with respect to space, time and causality makes the study of object permanence a particularly important focus for research in atypical populations. While researchers argue over which particular tasks appropriately reflect children's representational status as opposed to information processing capacity, object permanence and its associated measures remain at the centre of the psychology of infant development if only as a consequence of the vast literature which has accumulated on the subject.

As was noted at the beginning of this chapter, and previously in chapter two, research into the development of children with Down's Syndrome has stuck rather rigidly within a Piagetian framework. The predominance of this theoretical framework has led to constraints being applied in interpreting data from children with Down's Syndrome. In this section, the development of object permanence in children with Down's Syndrome is considered in the light of evidence from typically developing children. Evidence for an atypical cognitive profile in children with Down's Syndrome is also considered in relation to object permanence development.

Piaget believed that object permanence would emerge as a stagewise progression from sensorimotor to truly representational functioning towards the end of the second year. In the spirit of the 'organisational perspective' (Cicchetti and Beeghly, 1990) this implies that children with Down's Syndrome should follow a similar sequence in the development of the object concept and should show similar structural relationships between this and other skills.

Cicchetti and Beeghly argue that children with Down's Syndrome provide us with an opportunity to study structural relationships between developmental domains. The general slowing down of development allows us to distinguish between true structural convergences and developmental synchrony. When applied to sensorimotor development, these hypotheses imply that children should progress through sensorimotor stages in an invariant order observed in typically developing children. Secondly, relationships between domains of sensorimotor development should remain intact. Furthermore, where other domains of development are hypothesised to be structurally linked to sensorimotor development, say affective development, children with Down's Syndrome should also exhibit these links.

The next section will consider evidence for a similar sequence within the object permanence domain in children with Down's Syndrome and subsequently the structural relationships between object permanence and other developmental domains.

3.2.1 Children with Down's Syndrome, object permanence development and the similar sequence hypothesis

The similar sequence hypothesis implies that children with Down's Syndrome should progress through an invariant order of development within the sensorimotor domain according to the benchmark of typical development.

A study of the performance of children with Down's Syndrome on the Uzgiris and Hunt Scales (Uzgiris and Hunt, 1975) was carried out by Dunst (1990). The scales measure developmental progression in seven sensorimotor domains: object-permanence, means-ends abilities, vocal imitation, gestural imitation, operational causality, spatial relationships and sensorimotor schemes. Dunst claims that in terms of the sequential progression in performance within these domains, children with Down's Syndrome acquire sensorimotor competencies in a stagelike manner that is similar to typically developing infants. Dunst's claims are based on correlations between sensorimotor development and developmental age, similar to those reported for typically developing children (Uzgiris, 1987). Furthermore, Dunst reports finding only a few reversals in the typical ordinal pattern of development within domains. With regard to the progression through stages, Dunst examined both the transitional timing, i.e. the time taken to make progress to the next sensorimotor stage, and the stability of performance at a particular stage. Dunst reports that children with Down's Syndrome take longer to make transitions between sensorimotor stages, even when the slower pace of development is accounted for. Furthermore, Dunst reports that children with Down's Syndrome appear to show more regressions in performance than children without Down's Syndrome, as reported by Uzgiris (1987). According to Dunst, regressions in development could simply indicate a protracted period of structural reorganisation. However, regressions appear to be more frequent than found for typically developing children even when reduced by a factor associated with rate of development, namely developmental quotient. However, despite the apparent slowing down of developmental rate, neither Dunst (1990) nor Mervis and Cardoso-Martins (1984) found evidence for a 'developmental wall' at the transition stage V to stage VI which had been reported by Gibson (1978).

Structural relationships between sensorimotor domains were the cornerstone in Piaget's view of development as a domain general process. A child at stage III with respect to object permanence should be at a congruent stage in means-ends skills. In terms of stage congruence between sensorimotor domains, Dunst reports only low levels of congruence for children with Down's Syndrome which are at least 10% below levels of congruence reported for typically developing children. However, levels of stage congruence are low in both typically developing and children with Down's Syndrome. Therefore, increased heterogeneity in terms of developmental congruence may not reflect a violation of typical structural relationships.

In terms of sequential progression within the domain of object permanence and structural relationships with other domains it does not appear that children with Down's Syndrome exhibit striking irregularities in their performance. However, an examination of other evidence reveals anomalies in both the strategies and the error patterns in search behaviour which are not considered in Dunst's analysis.

3.2.2 Object permanence development and the similar structure hypothesis

The similar structure hypothesis implies that where structural relationships between domains exist in typical development these should be adhered to by children with Down's Syndrome. In this section a number of anomalies which are apparent in the performance of children with Down's Syndrome on object permanence tasks are outlined. These anomalies are viewed with respect to the relative strengths and weaknesses of children with Down's Syndrome outlined in chapter one.

Children with Down's Syndrome have been characterised as differing from normal children in the strategies which they use to solve object permanence tasks. Children are reported as using 'lower level' search strategies in order to recover objects (Wishart & Duffy, 1990; Morss, 1983). Such strategies include searching randomly in all locations rather than systematically searching or identifying a particular target for search. Wishart and Duffy (1990) report that children with Down's Syndrome often used 'sided' strategies in their search for an object hidden in one of two cups. A sided strategy entails the child searching in a specific location to left or right of herself when the object is hidden in one of two cups. When such a strategy failed (on average 50% of the trials) children showed little surprise and simply searched in the second cup. Morss (1983) also reports 'transitory side preferences' and a tendency to search exhaustively in all possible locations. Lower level search patterns such as these lack efficiency, and, while often successful in retrieving the object, do not reach standard criteria for 'passing' the task. Such apparent anomalies which characterise the performance of children with Down's Syndrome on object permanence tasks will now be considered in the light of developmental process which underpin performance in typically developing children.

3.2.3 How might a divergent path develop?

Theoretical arguments about the demands of object permanence tasks have focused on a number of domains of development and information processing requirements which impinge on task performance. A limitation in any contributory sub-domain or deficit in information processing could result in a delay in sensorimotor development and anomalous stage-incongruent performance. The performance of young infants on non-search tasks is heavily loaded on these infants underlying representational capacity. Search at stage IV, i.e. a single location, requires that children have the additional capacity to retrieve the occluded object. Later manual search tasks such as the two-location, stage IV task may therefore require higher-level cortical control of action and demand planning and inhibition of responses in addition to working memory demands. Stage VI object permanence tasks which require systematic search for invisible displacement of objects may incorporate a social element in children's performance (Fischer & Jennings, 1981). It does appear, therefore, that object permanence is not a unitary developmental concept but impinges on may other representational and information processing requirements at different stages in development. A divergence in the path of object permanence development in children with Down's Syndrome could arise for any number of reasons as is discussed below.

3.2.3.1 Early representational development

The study of early representational development in typically developing children has adopted a number of paradigms which obviate the need for children to make motor responses. While there is a growing trend towards the use of new paradigms such as visual preference and habituation for studying the early representational capacities of typical infants, this has not been matched in studies of atypical populations.

The experiments of Spelke (1988, 1990), Kellman and Spelke (1983), and Baillargeon (1986, 1987a, 1987b, 1991) inform us of sophisticated representational capacities in neonates and young infants which are pertinent to object permanence. While Miranda and Fantz (1973, 1974) have suggested the value of visual preference studies in children with Down's Syndrome, such studies in children with Down's Syndrome are rare (e.g. Lewis & Bryant, 1982). Problems with matching are often cited as reasons for avoiding atypical populations (Ganiban, Wagner & Cicchetti, 1990). If the early representational capacity evident in typical infants is indeed a precursor to performance on object permanence tasks then this is one area in which children with Down's Syndrome may be identified as divergent. However, children with Down's Syndrome show a relatively rapid progression in early sensorimotor performance followed by a gradual slowing down in pace (Dunst, 1990). These results do not, at face value, suggest either innate or early problems with object permanence per se.

A delay or deficit in the development of crucial cortical structures might result in a global delay in the attainment of a particular sensorimotor stage. The development of specific neural structures correlates well with achievement of sensorimotor milestones (Fischer, 1987; Goldman-Rakic, 1987). In children with Down's Syndrome a delay in myelination of the frontal cortex, as suggested by Nadel (1996), may have implications for planning and inhibitory control of action. Such a delay may be manifest as a delay or deficit in performance on higher level object permanence tasks which require increasing planning and control of action (Diamond, 1988). Mangan (1992) examined the performance of children with Down's Syndrome on cue learning, response learning, and place learning tasks. The particular deficit in place learning found in children with Down's Syndrome, in contrast to typically developing children, is consistent with hippocampal neuropathology. Dulaney, Raz and Devine (1995) argue that a deficit in an 'innate' cognitive function such as spatial memory suggests a divergent neural structure. Dulaney et al. argue that those with learning disabilities may be forced to use strategies for place memory where automatic processes are sufficient in typically developing infants. As Dunst (1990) comments, children with Down's Syndrome do not appear to show a specific delay in particular stage transitions. Furthermore, error patterns in children with Down's Syndrome do not suggest a particular planning deficit or a tendency to search perseveratively (Morss, 1983). However, the gradual slowing down in sensorimotor progress with age may reflect the increasing planning demands of the tasks and an underlying neurological deficit. While this thesis does not consider this possibility directly, one would expect any divergence in neurology to be reflected in children's performance and errors on standard and modified versions of object permanence tasks.

There are a number of areas in which children with Down's Syndrome have apparent strengths and weaknesses which may be responsible for anomalies in performance on object permanence tasks. Our subsequent discussion gives an account of potential ways in which the development of object permanence may proceed differently in children with Down's Syndrome.

3.2.3.2 Object permanence and motivation

In addition to quantitative distinctions in the performance of children with Down's Syndrome on object permanence tasks, recent research has drawn attention to qualitative differences in the search patterns and general motivation to search in children with Down's Syndrome. Typically developing children are characterised as being driven by 'competence motivation', and intrinsic desire to display competence (White, 1959; Harter, 1974). In general terms, Rast and Meltzoff (1995) refer to a dampening of such 'epistemic curiosity' in children with Down's Syndrome. This 'dampening' is in contrast to normal children who appear cognitively motivated to attempt object permanence problems, being bored with easy hidings and gaining interest in more complex hiding schemes. A dampening of epistemic curiosity is also implied by Wishart (1991) who finds young infants with Down's Syndrome less willing to 'explore' simple contingencies than a control group, and Wishart and Duffy (1990) who report a lower level of engagement in their sample of children with Down's Syndrome. In addition to a reduced willingness to participate in cognitive work, Wishart and Duffy report that children with Down's Syndrome appear to actively avoid engagement with the task and misuse social skills and employ 'party tricks' as means of avoidance.

There are two possible conclusions to be drawn from suggestions of a motivational deficit: either the deficit lies in underlying competence, or solely in performance. Furthermore it is clear that a performance deficit can readily become a deficit in competence via a 'failure to consolidate' learning. Karmiloff-Smith comments on the actions of a boy with Down's Syndrome, M.G., who, when faced with a balance-beam task, appeared to relearn every time. Karmiloff-Smith (1992/1995) explicitly links the achievement of behavioural mastery with attainment of representational status within domains, and this could equally be seen to apply to object permanence tasks. A general reduction in mastery motivation has been commented on by other researchers (Ruskin, Mundy, Kasari & Sigman, 1994) and could be seen as a limiting factor in the representational development of children with Down's Syndrome.

3.2.3.3 Object permanence and motor development

Children with Down's Syndrome are often hypotonic, or floppy at birth and exhibit a delay in achievement of gross and fine motor milestones. Some studies suggest that motor development may lag behind cognitive development by up to 10 months (LaVeck & LaVeck, 1977). Motor limitations may prevent typically developing children from recovering a hidden object until around six months despite possessing the requisite representational basis for a solution prior to this age. A specific motor delay in children with Down's Syndrome may detain solutions still further. Furthermore, motor experience may be crucial to children's development of more advanced object permanence skills. While many typically developing children are able to walk without support at around 12 months (range, 9 to 17 months), children with Down's Syndrome often do not walk unaided before around 19 months (range, 13 to 48 months) (Henderson, 1985). Piaget claimed that the child's progression in spatial understanding, from an egocentric to an allocentric view of the world, was founded on experience of self-propelled movement. There is evidence to suggest that individual differences on object permanence tasks may be related to experience of crawling or moving around in a baby walker (Kermoian & Campos, 1988; Gustafson, 1984). Self-propelled movement may therefore be a precursor for developing an understanding of spatial relationships and agency in typically developing children.

It is perhaps not surprising that typically developing children show some association between developmental milestones in both motor and cognitive performance. The domains may be linked by common maturational processes such as development of the prefrontal cortex (Diamond, 1991). Thus in typically developing children it may be inherently difficult to elucidate the direction of cause and effect in linking motor and cognitive performance. However, stronger evidence to suggest a causal relationship between locomotor and cognitive development may be gleaned from populations that experience a specific motor impairment relative to other domains. Gouin-Décarie (1969) describes a child, Jup, whose mother's treatment with Thalidomide resulted in profound deformity of her upper and lower limbs. When assessed at age 3 years 8 months, Jup had an IQ of 85 and could solve a stage VI object permanence task. The consequent of this child's ability to crawl does not appear to have had a profound effect on her intellectual development.

Could it be that children with Down's Syndrome exhibit a delay in spatial understanding, and consequently object permanence, which is due to earlier motor difficulties? The possibility that performance on object permanence tasks may be similarly linked to motor performance is examined in chapter nine.

3.2.3.4 Object permanence and social development

Recent research has shown that the developmental progression in object concept development may follow a distinct pathway in children with Down's Syndrome (Rast & Meltzoff, 1995). Rast and Meltzoff present evidence to suggest that deferred imitation skills emerge in children with Down's Syndrome prior to stage VI object permanence. From a Piagetian point of view the emergence of one form of representation, deferred imitation, before the emergence of representation in object permanence performance is contrary to the domain general view of sensorimotor development. Furthermore, the isolation of deferred imitation as a relative strength in children with Down's Syndrome, and object permanence as a corresponding weakness, may have implications for performance on object permanence tasks. Fischer and Jennings (1981) have identified a role for an understanding of external agency in high level object permanence tasks but limited such a role to children late in stage V of sensorimotor development. However, if an understanding of agency, as indicated by imitation, emerges earlier in children with

Down's Syndrome, it could be used as a cue in sensorimotor tasks much earlier than stage V.

The disparity between social and object related representations may reflect a more general developmental trait in children with Down's Syndrome. Rast and Meltzoff (1995) distinguish between 'empirical' and 'hypothetical' solutions to object permanence tasks (Meltzoff, 1990; Meltzoff & Gopnik, 1989). The authors distinguish these solutions according to their representational demands. Empirical representations stand for what was seen, in contrast to hypothetical representations which are constructed using deductive reasoning. Empirical representations facilitate deferred imitation while hypothetical representations are required to solve high level object permanence tasks. Rast and Meltzoff argue that children with Down's Syndrome may have privileged access to empirical representation over hypothetical representation. The development of deferred imitation skills and 'empirical representations' may therefore be reflected in somewhat atypical error patterns, especially on high level tasks which require hypothetical deductions to be made (Wishart & Duffy, 1990; Rast & Meltzoff, 1995; Morss, 1983). Furthermore, if children with Down's Syndrome have difficulty in inhibiting a tendency towards deferred imitation, as Krakow and Kopp (1983) suggest, then hypothetical judgements may not be readily apparent in their actions. In this case, the use of standard object permanence tasks may encourage the use of lower level strategies and consequent 'failure'.

3.3 Summary

Typically developing children do not begin to solve standard object permanence tasks until around eight months. However, evidence has shown that children can indicate knowledge of the properties of hidden objects well before solving such tasks (Baillargeon et al., 1990; Spelke, 1988; 1990). This contrast between children's apparent knowledge and their failure to search challenges the traditional view of search as a purely representational milestone. Many accounts suggest that search performance may be limited by children's ability to plan and inhibit manual responses (Diamond, 1988). A recent alternative account (Munakata et al., 1994) suggests that representation could be viewed as gradualistic, with stronger representations able to drive more complex search behaviour. Furthermore, it is important to recognise that limitations to performance may not be purely cognitive. Motivational and social factors may also have a bearing on children's performance (Wishart & Duffy, 1990; Bigelow, Macdonald & Macdonald, 1995). It is clear that both typically developing children and children with Down's Syndrome are required to deploy a diverse variety of social, cognitive and representational resources in solving the demands of object permanence tasks.

Children with Down's Syndrome develop differently from typically developing children in respect of a number of resources which are implicated in solutions to object permanence tasks. Children with Down's Syndrome may exhibit a particular delay in motor development which prevents them from searching despite underlying representational competence. Children with Down's Syndrome may also develop differently in neuropsychological terms and this may place limits on a number of cognitive capacities (Nadel, 1996; Mangan, 1992). Furthermore, a general tendency for children with Down's Syndrome to construct empirical representations in advance of hypothetical representations may impose limitations on solving object permanence tasks.

Just as typically developing children betray their limitations in making errors on object permanence tasks, divergent development and use of divergent strategies in children with Down's Syndrome should be reflected in performance on such tasks. Subsequent introductory chapters discuss in detail the evidence for performance on object permanence tasks being affected both by weaknesses, in motivation, and by strengths, in the social domain. This possibility is investigated in an experiment detailed in chapter 11. As was discussed in the present chapter, early sensorimotor experience was seen by Piaget as a precursor to mental representation and necessitates an increasingly sophisticated mastery of fine and gross motor skills over the first 18m of life. Chapter 9 describes a complementary experiment to examine the relationship between motor development and object permanence performance in children with Down's Syndrome.

Chapter 4

The Development of Representation: Language and Conceptual Development

The previous chapter considered the development of conceptual representations in children with and without Down's Syndrome. The current chapter examines the relationship between the development of representation in conceptual and linguistic domains. The boundary between representation in language and other cognitive domains is one of the most clearly drawn in psychology (e.g. Chomsky, 1965, 1982; Fodor, 1983) but few psychologists would deny that language is strongly dependent on representational development in general. This chapter focuses firstly on the evidence for the role of cognitive representations in the linguistic development of typically developing children. Having introduced the theoretical links between linguistic and cognitive representation in general terms, the relationship between specific cognitive and linguistic milestones are discussed. The pattern of language development in children with Down's Syndrome will subsequently be described with reference to the pattern observed in typical development.

4.1 *The role of general cognition in language development*

There is strong evidence to suggest that some aspects of language, particularly syntax, could not be derived from general, non-linguistic, representational capacity, or cognition. Such evidence supports constraints on representation which are exclusively applied to the process of language acquisition (Chomsky, 1965, 1982; Tager-Flusberg, 1994). In this section the extent to which language may be regarded as a modular process is initially discussed in relation to its general dependence on cognitive processes.

4.1.1 The domain general view of language development

Piaget regarded linguistic representation as subordinate to a more general representational capacity, the semiotic function. According to Piaget, language emerges as a consequence of the child's capacity for mental representation which develops at around 18 months (Piaget, 1959) . Thus language and non-linguistic cognitive representations, according to Piaget, are inextricably bound to the same representational system.

Piaget argued that, prior to the 18 month transition, mental, and by implication pre-linguistic operations would be manifest in behavioural action schemes. Furthermore, the semiotic function, emerged as a result of the internalisation of action schemes. Thus Piaget argued for the primacy of sensorimotor development in the development of language, at least up until the end of the sensorimotor period.

Some authors argue for a structural relationship between sensorimotor action schemes and language. For example, a child's tendency to place one container inside another could be viewed as a sensorimotor prerequisite to the embedding of clauses within a sentence structure (Greenfield, Nelson, & Saltzman, 1972). Cognitive concepts of agent, action and patient may also map onto equivalent syntactic concepts of subject, verb and object (Pinker, 1984). Thus, linguistic competence is constructed by the child on the basis of sensorimotor development (Sinclair, 1987; Anisfeld, 1984).

However, many researchers argue that linguistic structures, and particularly syntax, could not possibly arise solely as a result of a general capacity for symbolic representation without specific linguistic constraints (Karmiloff-Smith, 1992/1995; Chomsky, 1965, 1982; Pinker, 1984). There is evidence for a number of constraints on linguistic development which cannot be explained with sole reference to general cognitive processes. For example, children do not appear to make gross errors in their spontaneous utterances as would be predicted if governed by generalisations from a cognitive basis. In contrast, error patterns in children's spontaneous utterances suggest the application and overextension of linguistic rules (Goodluck, 1991). The regularity and consistency with which children learn language implies the existence of specific linguistic constraints outside of the cognitive domain.

Further evidence for a clear dissociation between language and cognition comes from studies of atypical language development. Evidence from children with learning disabilities suggests that complex linguistic development can occur despite profound cognitive impairment (Cromer, 1994; Bellugi, Marks, Bihrle, & Sabo, 1988; Udwin, Yule, & Martin, 1987). Such a powerful dissociation between cognitive and linguistic performance indicates that the two domains may be governed by separable developmental processes.

However, it is clear that if language is to be meaningful then it must to some extent engage with conceptual representation and general cognition. Chomsky's example of a grammatically well formed, but meaningless, sentence, 'Colourless green ideas sleep furiously' clearly illustrates the contrast between syntax, and semantics. The area of semantics and pragmatics provide a clear role for cognitive factors in the acquisition of language. Pragmatics refer to the communicative function which language serves whilst semantics refer to the meaning which words and sentences convey. Many nativist views fail to address these crucial components in children's communicative competence (Chomsky, 1965).

4.1.2 The relationship between semantic, pragmatic, and syntactic development

Even a staunch nativist must acknowledge that the child's semantic-conceptual and pragmatic awareness must impinge on the language learning process at some level (Braine, 1994). During lexical development the child must use cognitive skills to develop an understanding of word meaning, or semantics. Furthermore, pragmatic skills must be deployed to understand the communicative process in general. The process by which semantic and pragmatic knowledge constrains children's language acquisition is central to the 'cognition hypothesis' and will now be discussed.

Theoretical approaches to pragmatics tackle the problem of how children acquire, develop and understand communicative intent. Bruner (1978) suggests that this pragmatic side of language development occurs as a consequence of 'social scaffolding' provided by the parent. This scaffolding subsequently acts in support of syntactic development for which Bruner concedes control to Chomsky's Language Acquisition Device. Tomasello (1992, 1995) similarly emphasises the conceptual and pragmatic constraints which constrain children's understanding of adult reference.

In order for children to understand referential communication, some constraints are certainly necessary. When an adults refers to an object or event, the child needs to understand precisely which event or object the adult is referring to, from an array of possibilities. The infant is also required to divide up the world into objects and events pertinent to linguistic representation (Karmiloff-Smith, 1989, 1992/1995). For example, when an adult points to a cat, and says "look, a cat" the child must interpret whether the adult is referring to the cat's fur, or whiskers, or to the whole animal.

Many researchers emphasise the importance of constraints derived from conceptual knowledge which govern successful understanding of adult references (Tomasello, 1992, 1995; Mandler, 1992). Barton and Tomasello (1994), for example, find empirical evidence which suggests that children's awareness of an action as purposeful or accidental constrains the meaning which they attach to the corresponding adult reference. Mandler (1992) suggested that semantic constraints may act as an early guide for children's perceptual and conceptual processing of events and thereby constrain the possibilities for understanding adult reference.

Further empirical evidence for semantic constraints on linguistic acquisition focuses on children's early 'telegraphic' speech. At this stage, children tend to use words which map out semantic categories such as that of agent, action, and patient (Bowerman, 1973). This evidence suggests that these semantic categories could map directly onto syntactic categories of subject, verb, and object (Greenfield, Nelson & Saltzman, 1972). Pinker (1984, 1989), whilst emphasising some language specific structural constraints, argues that such early knowledge of semantic relations is the key to an acquisition of more complex grammatical structures. Tomasello's (1992) account of verb learning also emphasises the social-pragmatic cues which constrain the child's understanding of linguistic reference and allow semantic relations to prime the acquisition of syntax.

While it seems intuitively reasonable to suppose that the child's knowledge of semantic relations will to some extent map onto developing language there are clear limitations to this mapping process. Certainly not all nouns are 'things', and not all verbs are actions, so a child must at some stage come to represent abstract linguistic structures which do not have semantic equivalents. Gleitman (1990) argues that while semantic constraints certainly have a role to play in linguistic development, they alone cannot account for children's ability to understand the distinction between closely related verbs. Verbs such as "look" and "see" for example cannot be distinguished on a semantic basis. Gleitman argues that in such circumstances the child's knowledge of syntax facilitates understanding of an utterance. Landau and Gleitman (1985) argue that it is via this process that blind children are able to generate hypotheses about the meaning of "look" and "see" by appealing to evidence from the syntactic framing of such verbs. For example a child might hear "I saw the ball" and " I looked at the ball" but not "I looked the ball" or "I saw at the ball". Gleitman (1990) argues that the syntactic frame acts as a 'mental zoom lens' and fixes the possible interpretations of such utterances. What is at issue here is the extent that the semantic process may support the acquisition of syntax and vice versa. The use of syntax to support semantic development is referred to as 'syntactic bootstrapping' (Gleitman, 1990) whilst the converse process in which semantic constraints influence syntactic development is referred to as 'semantic bootstrapping' (Pinker, 1984, 1989). The relative extent to which these processes are implicated in the development of language mark out the battleground in the debate regarding links between language and cognition.

It appears however, that regardless of its precise aetiology, the process of lexical acquisition may have implications for subsequent language development. Evidence suggests that lexical acquisition, and particularly the acquisition of verbs, may be instrumental in priming a process for the development of syntax.

Anisfeld (1984) suggests that the lexical 'naming explosion' which typically occurs around 18 months may be a necessary prerequisite for the growth of early syntax. Anisfeld argues that the correlational patterns which emerge when comparing children's lexical development to increases in MLU are more than coincidental. Bates, Bretherton and Synder (1988/1991) also suggest that the grammatical complexity in a child's language at 28 months may be entirely predicted by lexical development at 20 months. The continuity between lexical and syntactic development, referred to as the 'critical-mass' hypothesis is supported by both connectionist models of language acquisition (Plunkett & Marchman, 1993) and naturalistic studies (Marchman & Bates, 1994). Bates et al. (1988/1991) conclude that lexical and grammatical development may be paced by the same mechanism.

Furthermore, there may be something 'special' about the acquisition of verbs which is implicated in children's grammatical development (Bates et al., 1988/1991). Bates et al. argue that the 'verbiness' apparent in a child's lexical style may predict later grammatical complexity and act as a 'booster rocket' for language development.

Tomasello (1992) also suggests that verbs many provide essential building blocks around which early grammar is constructed. Tomasello claims that children's early multi-word speech is produced without explicit knowledge of 'syntagmatic' categories such as 'Direct-Object' or 'Agent' and 'Patient'. However, children construct verb-specific semantic relations such as 'hitter' and 'thing hit' which exist as islands of organisation. Tomasello refers to his claim as the 'verb island' hypothesis in which verb by verb organisation is gradually generalised as a paradigmatic category. Tomasello proposes that later syntactic development may proceed with extension of known structures to new linguistic material as outlined by Pinker (1989). What is crucial to Tomasello's account is that it attributes to the initial acquisition of verbs a profound significance in the child's global syntactic development.

The evidence and theoretical arguments for some native constraints on children's multi-word speech is persuasive (e.g. Chomsky, 1982). However, regardless of these constraints, there is a growing consensus that early lexical acquisition may be strongly dependent on semantic-conceptual and pragmatic representations (Tomasello, 1992, 1995; Bruner, 1978; Pinker, 1984, 1989). Furthermore, a number of theoretical accounts suggest that syntax development may be founded on lexical acquisition and particularly the acquisition of verbs (Anisfeld, 1984; Bates et al., 1988/1991; Tomasello, 1992, 1995).

Despite dissociation between language and cognition observed in older children, these domains may be linked and interdependent at the single word stage. With reference to development in atypical populations, any discrepancy in cognitive representations may have its greatest impact during early as opposed to later linguistic development. In the following section, the discussion focuses on the evidence which links language and conceptual representations at the single word level in typically developing children.

4.1.3 Language development and cognitive prerequisites at the single word level in typically developing children

Piaget (1951/1967) argued for 'cognitive prerequisites' in the sense that the 'semiotic function' arose from cognitive development and was the sole basis for language development. Strong forms of the cognitive prerequisites view, such as that espoused by Piaget, and Werner and Kaplan (1963), are untenable in the light of the evidence for native structure (Chomsky, 1965, 1982; Pinker, 1984). However, a weaker form of the cognitive prerequisites view is both theoretically defensible and is well supported by evidence (Gopnik & Meltzoff, 1986). This view suggests that children's early linguistic reference may depend on specific cognitive structures at specific points in time.

Brown (1973) and Bloom (1973) argue that before referring to objects linguistically, children must be aware that such objects exist. The authors therefore suggest that a high level of object permanence should be a cognitive prerequisite for linguistic reference to objects. Problems with such general association are that there are numerous measures which reflect both the child's emergent language and object permanence. A number of studies reported by Corrigan (1979) have tested associations between various stages of object permanence, with a corresponding variety of linguistic measures including the onset of naming, measures of comprehension, productive vocabulary size and MLU. The results of such studies do not suggest a consistent relationship between these cognitive and linguistic domains. Furthermore children's linguistic reference to objects and events often precedes the transition from sensorimotor development (Gopnik, 1988; Harding & Golinkoff, 1979).

Broad linguistic measures, such as those in the studies cited by Corrigan, are likely to be influenced by a range of pragmatic or social factors and hence the contribution of cognitive prerequisites may be overshadowed (McCune-Nicholich, 1981). McCune-Nicholich reports however that object permanence, and specifically the attainment of stage VI, is consistently followed by the emergence of relational words in children's vocabulary. Relational words are those referring particularly to the 'dynamic state of objects' such as *up*, *more*, and *gone*.

Further evidence for a relationship between object permanence and the acquisition of relational verbs comes from Gopnik and Meltzoff (1984). Gopnik and Meltzoff present evidence for a relationship between the child's solution of invisible displacements in object permanence tasks and the acquisition of *gone* in the child's vocabulary. Furthermore, Gopnik and Meltzoff find a similar association between children's linguistic coding of success and failure, as indexed by acquisition of 'no', 'uh-oh' and 'there' and solution of means-ends task requiring the use of string to retrieve an object. Gopnik and Meltzoff argue that these correspondences reflect both the development of a conceptual or semantic basis for the terms and the fact that particular cognitive advances motivate the child to acquire a linguistic means of reference. The authors comment that the child 'invents a system that encodes the meanings that are important to him' (p. 512). Gopnik and Meltzoff (1986) find further evidence that cognitive advances in categorisation are related to the onset of the naming explosion which often occurs around 18 months in typically developing children. Gopnik and Meltzoff claim that it is specifically categorisation rather that representation per se which drives children to code such categories with linguistic references.

Gopnik and Meltzoff's claims are summarised as the 'specificity hypothesis' (Gopnik & Meltzoff, 1986) which proposes that the emergence of specific linguistic features will correspond to specific cognitive advances. Evidence for this hypothesis is presented in terms of the common representational basis for the emergence of linguistic and cognitive skills. However, the representational account offered by Gopnik and Meltzoff (1986) is to be distinguished from Piaget's view, as will now be discussed.

Meltzoff and Gopnik (1989) address the problem inherent in a Piagetian view of language development, that linguistic development must apparently await the emergence of the semiotic function corresponding to stage VI of sensorimotor development, around 18 months. There is broad evidence against this, suggesting that linguistic reference may occur as early as stage V of sensorimotor development (Corrigan, 1979). Meltzoff and Gopnik argue that the transition which occurs at around 18 months is not the emergence of representations per se but a transition to hypothetical representation.

The emergence of hypothetical representations appears to mark a global shift in children's linguistic references. Meltzoff and Gopnik claim that prior to 18 months children's language is comprised of mainly social, often reinforced, words, such as 'hereyare' and 'bye-bye', or words which refer to salient objects such as 'dog', or 'ball'. In contrast, following the shift towards hypothetical representations, children begin to use words which code for the distinction between actual and possible states of affairs. Such words, according to Gopnik and Meltzoff are those such as 'gone' and 'uh-oh'.

The data on which Meltzoff and Gopnik base their broad claim is essentially correlational. Much of the evidence presented in favour of cognitive prerequisites is similarly based on correlations between measures (Bates et al., 1988/1991; Corrigan, 1979). Such evidence does not therefore permit us to conclude that cognition causes linguistic development, or indeed that linguistic development is influencing cognition.

Tomasello and Farrar's (1984) 'Prerequisites model' suggests that cognitive skills are genuine causal precursors to the development of linguistic skills. Tomasello argue on theoretical grounds that relational words should be broadly subdivided into two categories, visible displacement (move, fall-down, etc.) and invisible displacement (gone, find, more, etc.). Tomasello and Farrar argue that whilst a concept of invisible displacement (stage VI) is required for correct use of 'gone', 'find' and 'more', such a concept is not necessarily required for relational words limited to the visible movement of objects (move, fall down, etc.).

Tomasello and Farrar (1986) tested the causal relationship between performance on object permanence tasks and the emergence of relational words. Children were trained to use nonsense words related to the visible and invisible displacement terms. While children at stage VI were able to learn both the visible and the invisible displacement terms, children at stage V were only able to learn the term related to visible displacement. This study suggests the primacy of cognitive advances over linguistic advances and stands in contrast to Bates et al.'s claim for the representational equity of the two domains. Tomasello accepts that there may be benefit from hearing adults use words which support cognitive advances but concludes that in particular instances conceptual development is a prerequisite to language comprehension and production.

In summary, much of the evidence for links between cognitive and linguistic domains tends to rely on correlational data (Bates et al. 1988/1991; Gopnik & Meltzoff, 1984, 1986; Corrigan, 1979). Such studies are routinely criticised for failing to offer more than a description of development and for a lack of causal evidence. Alternative attempts to manipulate conceptual and linguistic development are rightly limited by ethical considerations. However, studies of populations with pre-existing conceptual or language problems allow an examination of the relationship which goes beyond that available within 'normal' populations. Children with Williams Syndrome show an uneven cognitive profile in which lexical, semantic and phonological aspects of language are seen as relative strengths whilst general cognitive development is severely impaired (Bellugi et al., 1988). In contrast, children with Fragile-X syndrome show deficits in the phonological and syntactic subdomains while lexical acquisition is spared (Rondal, 1996).

It is clear that the pattern and style with which children from atypical populations learn language has much to offer in terms of elevating our understanding of the relationship between representation in the cognitive and linguistic domains. Data from atypical populations allows us to examine the coherence and relative independence of language development and thereby discriminate causal influence from coincidence. The following section will consider ways in which language development in children with Down's Syndrome both converges and diverges from typical developmental models. The ways in which evidence might help us to identify causal links between linguistic and cognitive domains is also examined.

4.2 The development of language in children with Down's Syndrome

Many claims have been made suggesting that the development of language in children with Down's Syndrome is 'delayed without deviance' (Lenneberg, Nichols & Rosenberger, 1964). This suggestion assumes that language development in children with Down's Syndrome follows a similar sequence and structural organisation to that observed in typically developing children.

However, despite this claim, the language development of children with Down's Syndrome is clearly different. Language development in children with Down's Syndrome appears to lag behind cognitive development in general (Mahoney, Glover & Finger, 1981; Cardoso-Martins, Mervis & Mervis, 1985). There is further evidence to suggest that even during early lexical acquisition the language development of children with

Down's Syndrome fails to keep pace with cognition (Mahoney, Glover & Finger, 1981; Cardoso-Martins, Mervis & Mervis, 1985; Mervis, 1990).

In the previous section it was argued that during the period of early lexical acquisition the relationship between the linguistic and cognitive domains should be at its strongest. The observed disparity between early language and cognitive development in children with Down's Syndrome is therefore particularly surprising. In this section the discussion will focus on evidence for correspondence between Down's Syndrome and typical development in respect of these links. Given theoretical arguments which support a modular view of language development the evidence for relative coherence within the linguistic domain is first discussed. Subsequently we address the question of apparent disparity between the development of language and cognitive skills in children with Down's Syndrome.

4.2.1 Language development and the similar sequence hypothesis

The coherence and regularity with which typically developing children develop language was the subject of our initial discussion. The sequential process of language acquisition in children with Down's Syndrome is of particularly theoretical significance with respect to argument for a domain specific or modular structure to language development. Furthermore, the similar sequence hypothesis (Cicchetti & Beeghly, 1990) implies that sequential development within domains should follow a typical pattern in children with Down's Syndrome. If a typical pattern of sequential development is to be found, one might expect language development to be an obvious focus. In this section the evidence for a similar sequence in language development is discussed.

Linguistic development in children with Down's Syndrome rarely proceeds beyond the simple phrase-structure grammar characteristic of a typically developing 2-year-old (Fowler, 1990; Miller, 1988). Lenneberg (1967) suggested that this lower ceiling of linguistic development in children with Down's Syndrome was due to the end of a critical period of brain plasticity which coincided with the onset of puberty. Such a view is consistent with theoretical perspectives which argue for native structure in language development. Furthermore, while it is certainly clear that language development lags behind chronological age, there is a substantial body of evidence which points to the relative coherence of development within the linguistic domain (Fowler, 1990; Cunningham, Glenn, Wilkinson & Sloper, 1985; Rondal, 1996).

Studies which suggest the coherence of language development in children with Down's Syndrome have considered the structural components of language when compared to typically developing children matched for mean length of utterance, or MLU. Brown (1973) proposed a stagewise description of language development indexed by MLU. These stagewise divisions, according to MLU, provide a useful empirical tool for matching grammatical complexity. When children with Down's Syndrome and typically developing children are matched for MLU, any structural differences in grammatical development should be apparent as a discrepancy between characteristics of grammatical morphology used at this stage. Fowler, Gelman and Gleitman (1994) argue that when such matching procedures are adopted, children with Down's Syndrome fail to demonstrate any striking discrepancies in the structural aspects of production. The authors remark that these results serve to strengthen the notion of language as a 'monolithic indissociable "normal" system proceeding at a slower pace' (p. 113).

As Fowler et al. note, it is surprising that a child can learn 'normally' over a period of 12 years what is otherwise acquired in 30 months. The slower rate of linguistic development in children with Down's Syndrome and the lower developmental ceiling demand an explanation. Fowler et al. (1994) comment that the existence of a ceiling at a particular level of syntax does not have the properties of a simple innate, or maturational, limitation. The coherent but slower process which characterises development within the linguistic domain stands in contrast to structural incoherence between language and other domains. It may well be that explanations for both the slower rate and premature ceiling in language development lie outside the linguistic domain. The subsequent discussion considers in particular the structural anomalies which characterise the relationship between language development and other domains.

4.2.2 Language development and the similar structure hypothesis

As we have noted, children with Down's Syndrome do appear to possess a characteristic profile of strengths and weaknesses. Children with Down's Syndrome are regarded as relatively advanced in the domain of social functioning whilst weak in the domain of language. Given the communicative function of language one might expect that pragmatic development would eclipse the relative weakness in language development. Furthermore, language development is characteristically delayed in comparison to general cognition. It therefore appears that within language development pragmatic and semantic-cognitive development should be relatively strong. There is substantial evidence for a mismatch between the pragmatic and semantic aspects of language in contrast to syntax development in children with Down's Syndrome. The structural relationships between language and each of these domain strengths will now be discussed.

4.2.2.1 Language and social-pragmatic development.

The comparison of children's social-pragmatic skills also reveals a relative strength in communicative development which is not matched in linguistic sophistication. Bruner (1977) saw early pragmatic development as the 'scaffolding' which facilitates later acquisition in typically developing children. Leifer and Lewis (1984) suggest that the grammatical weakness of spontaneous utterances may disguise strong pragmatic communicative skills of children with Down's Syndrome. Leifer and Lewis studied the ability of children with Down's Syndrome to respond appropriately to questions and prompts from their mothers in comparison to a group of typically developing children matched for linguistic complexity. Results indicated a set of response skills in children with Down's Syndrome which were in advance of the typically developing group. Beeghly, Weiss-Perry, and Cicchetti (1990) found the communicative abilities of children with Down's Syndrome to be more mature than typically developing children matched for

MLU, but similar to children matched for mental age. These studies point to a specific impairment in linguistic skills which stands in contrast to a relative strength in the non-verbal social-pragmatic domain. However, some recent research has shown that despite apparent independence, performance in the non-verbal pragmatic domain may predict later linguistic performance in children with Down's Syndrome (Mundy, Kasari, Sigman & Ruskin, 1995). Mundy et al. (1995) interpret their results as indicating the primacy of the social-pragmatic deficit as a causal influence in language development.

The apparent contradiction between these results outlines a problem in comparing studies across a broad age range. Whilst in a sample of older children, matched for MLU, children with Down's Syndrome are clearly advanced in pragmatic skills (Leifer & Lewis, 1984), in younger children a more coherent general deficit is reported spanning both pragmatic and linguistic skills (Mundy et al. 1995).

Similar problems emerge in comparing children's linguistic performance to semantic-conceptual measures. Fowler et al. (1994) report evidence for a discrepancy between semantic and syntactic development in children with Down's Syndrome with syntax relatively delayed. This discrepancy is also supported by a number of other studies (Dunst, 1990; Beeghly, Weiss-Perry and Cicchetti, 1990; Mervis, 1990). It is clear therefore that in older children with Down's Syndrome semantic and pragmatic development appears relatively advanced with respect to syntax. This disparity may lead to the conclusion that syntactic development could not be limited by deficits in either pragmatic or semantic-conceptual domains. However, such studies are based on children spanning a broad range of development and on theoretical grounds, as was argued in the previous section, associations between linguistic and conceptual development may be restricted to the one word stage. Furthermore, it is at the early stages of language development that semantic and pragmatic skills may exert a causal influence on the development of syntax (Bates et al, 1988/1991; Tomasello, 1992, 1995).

It therefore makes sense to restrict empirical investigation and our discussion to development at the one word stage. In the following section we consider the emergence of semantic and linguistic development focusing on this period.

4.2.2.2 Language and cognitive-semantic development

The dramatic delay in linguistic development of children with Down's Syndrome has prompted research into the links with general cognitive development. The motivation for such studies stems from the Piagetian notion that early lexical reference is parasitic upon sensorimotor development despite the fact that this view is relatively unsupported in studies of typically developing children (Corrigan, 1979).

Greenwald and Leonard (1979) explored the relationship between communicative behaviour and sensorimotor development in children with Down's Syndrome. Two groups of children with Down's Syndrome at sensorimotor stages IV and V were compared to typically developing children matched for sensorimotor development. Whilst group differences in communicative behaviour as indicated by pre-linguistic 'imperative' and 'declarative' gestures were not evident at stage IV, by stage V some differences emerged. Greenwald and Leonard noted that while the typically developing children had begun to use verbal declaratives at stage V, children with Down's Syndrome had not. Cardoso-Martins, Mervis and Mervis (1985) investigated lexical acquisition compared to the rate of sensorimotor development in children with Down's Syndrome. The results show that the onset of referential communication may correspond quite closely to cognitive performance.

Despite this early association between cognitive transitions and the onset of reference, the rate of lexical acquisition in children with Down's Syndrome fails to keep pace with sensorimotor development. Mahoney, Glover and Finger (1981) carried out a study comparing the performance of children with Down's Syndrome and typically developing children on sensorimotor performance and measures of language comprehension and production. The authors report that despite being well matched in terms of sensorimotor development, children with Down's Syndrome scored significantly lower on linguistic measures.

The evidence presented so far suggests that in children with Down's Syndrome the generally observed delay in linguistic development relative to cognition may extend to the onset of lexical reference (Greenwald & Leonard, 1979; Cardoso-Martins et al., 1985; Mahoney et al., 1981). These results suggest firstly that there is little evidence for strong links between language and cognitive skills in children with Down's Syndrome and furthermore that the linguistic deficit cannot therefore be attributed to a general cognitive delay. However, these studies are based on theoretical assumptions of a broad correspondence between linguistic and sensorimotor development for which there is weak evidence in the typically developing population (Corrigan, 1979). A recent study carried out by Hassan and Messer (1995) tested the relationship between linguistic and cognitive measures with some more precise indicators which do appear to be related in typically developing children.

Hassan and Messer recorded the emergence of relational verbs such as 'gone', 'uh-oh', etc. in relation to the development of object permanence and means-ends skills in a longitudinal study of children with Down's Syndrome. The relationship between the emergence of linguistic terms and cognitive performance is outlined in the cognitive specificity hypothesis (Gopnik & Meltzoff, 1986). To recap, Gopnik and Meltzoff hypothesised that the emergence of 'gone' should be tied to performance at stage VI of object permanence, whilst terms which refer to success or failure such as 'uh-oh' should be related to the attainment of stage VI on means-ends scales.

Hassan and Messer report a counterintuitive pattern of results in relation to the cognitive specificity hypothesis. Many of the children studied acquired linguistic and signed referential terms prior to the corresponding cognitive transition. Although there is some doubt as to the equivalence of lexical and signed reference (Goodwyn & Acredolo, 1993). Miller, Sedley and Miolo (1995) argue that such measures should be included when assessing linguistic performance in children with Down's Syndrome. However, even when signs are excluded, a number of children produced spoken referential terms prior to reaching the respective cognitive stage. These results are particularly surprising given evidence for a reliable delay in linguistic development relative to cognitive development in children with Down's Syndrome. With the caveat that in the case of correlational designs there is no indication of a causal relationship between domains, Hassan and Messer's results suggest a contradiction of 'cognitive specificity' within this population.

The predictions made by semantic bootstrapping and the cognitive specificity hypothesis suggest that in order to acquire conceptually laden lexical terms the child must first acquire the associated semantic or conceptual basis. The finding that children with Down's Syndrome, or indeed typically developing children, might follow the opposite pattern is theoretically challenging. However, recent evidence has suggested that measures of sensorimotor development which are crucial to such findings, may not give a reliable indication of the cognitive competence of children with Down's Syndrome. Researchers have found (e.g. Wishart, 1991; Morss 1983) that children with Down's Syndrome may not perform with the same degree of stability as typically developing children on tasks such as the object permanence scale. If such instability is present, it may have methodological implications in rendering the assessment of cognitive development unreliable. The puzzling results reported by Hassan and Messer may therefore reflect problems in the assessment of cognitive development rather that an anomalous relationship between linguistic and cognitive attainments.

However, the instability in conceptual performance reported by Wishart (1991) and Morss (1983) may yet have developmental consequences for linguistic development. Gopnik and Meltzoff refer to the importance of salient developmental milestones in driving the process of lexical reference. If the salience of conceptual milestones is weakened by instability then acquisition of corresponding lexical terms may be affected.

4.3 Summary

Studies of typically developing children argue strongly for a nativist account of linguistic development. However, a number of researchers have pointed to the importance of a number of specific semantic relations for the later acquisition of syntax. Empirical studies of links between conceptual and linguistic domains of development when focused on broad measure of linguistic and conceptual competence, have yielded mixed results. However, Gopnik and Meltzoff (1986) provided a theoretically driven account for specific links between cognitive advances in the sensorimotor domain and acquisition of relational-verbs. Tomasello and Farrar (1986) add weight to a prerequisites view of these cognitive skills in relation to the acquisition of relational-verbs. Given the relative importance of the acquisition of relational terms in children's early grammatical development it may be that particular cognitive skills, while less important later in development, provide the impetus for language development.

Across the domains which comprise language, children with Down's Syndrome display a surprising structural coherence which lies well within models of language development seen in typically developing children (Fowler et al., 1994). However, the rate of early vocabulary acquisition is slower in children with Down's Syndrome than in normally developing children, even when the slower rate of cognitive development is accounted for (Mervis, 1990) and children reach a lower ceiling in terms of grammatical complexity (Fowler et al., 1994).

In contrast to the coherence within the linguistic domain, children with Down's Syndrome have exhibited a growing discrepancy between language development and general cognitive skills (Fowler et al., 1994; Rondal, 1996; Miller, 1988). A number of studies have seized upon the potential for a cognitive explanation of the linguistic deficit in children with Down's Syndrome and have investigated the relationship between advances in the two domains with mixed results. Many such studies which compare broad cognitive measures with broad linguistic measures, fail to capture the theoretical specificity of links between cognitive and linguistic domains such as those proposed by

Gopnik and Meltzoff (1986). One study of children with Down's Syndrome which investigated the cognitive specificity hypothesis yielded anomalous results (Hassan & Messer, 1995). There are a number of possible theoretical predictions which remain unexplored.

Studies which show a discrepancy between linguistic and cognitive measures lead to a number of plausible conclusions. Given the apparent disruption to development in children with Down's Syndrome it may be that the links between cognition and language are absent or different in this population. Alternatively, we could argue that links between language and cognition are absent in both populations. Empirical investigation of links between cognitive skills and language in children with Down's Syndrome may inform both theoretical debate and practical interventions. The theoretical issues focus on the extent to which specific cognitive skills may be necessary and/or sufficient for acquisition of corresponding lexical terms. Interventions may be focused on factors found to influence the rate of lexical acquisition which may have consequence for grammatical development (Mervis, 1990). Recall that Anisfeld (1984) cited the rapid rate of lexical development observed in typically developing children as a causal influence on early combinations of words. Therefore the absence of a period of rapid lexical acquisition in children with Down's Syndrome may have implications for subsequent language development. An investigation of the links between specific cognitive and lexical advances is therefore warranted from both a theoretical and practical perspective.

The empirical study described in chapter 10 addresses the question of the relationship between specific conceptual achievements and lexical acquisition. Furthermore, this investigation quantifies the level of performance instability in order to address the possibility that instability itself may have implications for lexical acquisition.

Chapter 5

The Development of Representation: The Role of Imitation

While language is consistently viewed as a relative weakness in children with Down's Syndrome, imitation and social development are seen as relative strengths (e.g. Gibbs & Thorpe, 1982; Rast & Meltzoff, 1995). In this chapter the representational basis for imitation is discussed with reference to its typical developmental characteristics. In relation to children with Down's Syndrome the extent to which imitation may be regarded as a domain strength is first considered. The consequences of a propensity for imitation in relation to other developmental processes will subsequently be addressed.

In previous chapters, discussion has focused on development within circumscribed domains, sensorimotor or linguistic respectively, and summarised the representations which form the basis for links between these domains. The present discussion of imitation is unique in the sense that imitation is rarely regarded as a domain of development but is seen as a pervasive developmental process with a role to play within a number of domains. In chapter 3 it was argued that there may be a 'link' between imitation and development within the object permanence domain. However this link is best regarded as a role for imitation in the development of object permanence. Despite this apparent shift of emphasis from representational links to developmental processes, in the following section it is argued that imitation, as a process, conveys representations.

5.1 Imitation as Representation

The study of imitation is important to developmental psychologists and assumes a central role in developmental theory (Piaget, 1951/1967; Meltzoff, 1990). Furthermore, imitation is often seen as a revealing expression of children's representational status. Imitation occurs spontaneously in very young children and therefore provides an empirical tool with which to examine the emergence of representations. Imitation has also been implicated as playing a fundamental role in both language and social development (Meltzoff, & Gopnik, 1989; Rogers & Pennington, 1991; Snow, 1989). In language development, imitation allows children to appropriate new sounds (Snow, 1989; Solokov, 1992). In terms of social representations, children's capacity for imitation clearly reflects the growing distinction between self and others (Piaget, 1951/1967). Conversely, the representation of other humans as being 'like me' endows the child with a propensity for social learning via the imitation of the actions of others (Meltzoff 1988; Meltzoff & Gopnik, 1989). The close correspondence between early play and imitative development is also described in Piaget's (1951/1967) 'Play, Dreams and Imitation in childhood' and it is clear that both play and imitation as complementary developmental processes provide a 'window on the child's representational world' (Bergman & Lefcourt, 1994).

This chapter discusses the development of imitation skills in infants and expands upon the developmental role which imitation may serve. The relationship between imitation and object permanence was introduced in chapter 3 and will be expanded upon in the present chapter. We begin by discussing the development of imitation from the perspective of typical development and conclude with a discussion of the role of imitation as a developmental process in children with Down's Syndrome.

5.2 The development of imitation in typically developing children

5.2.1 The role of imitation as a developmental process

The development of imitation in typically developing children is an integral part of early representational development according to Piaget (1951/1967). Imitation as a means of co-ordinating the observation and production of action is fundamental to the Piagetian view of action as a precursor to thought. The Piagetian course of development comprises the complementary processes of assimilation and accommodation. While assimilation involves the incorporation of new experience onto existing structures, during accommodation, new structures are added to the child's repertoire. Intelligence, according to Piaget, represents the achievement of a balance between the processes of assimilation and accommodation. Assimilation applies existing schemes to new objects in new contexts while accommodation adapts existing schema to represent new objects. Imitation, as an extension of accommodation, is the means by which children append new experiences to their internalised repertoire. Without the imitation process, assimilation would proceed unchecked, perpetually distorting objects to fit existing schema. Conversely, without assimilation, imitation would fail to produce co-ordination or comprehension of new experiences. In Piagetian terms it is essential that the process of imitation which provides new schema is matched by a tendency to assimilate new experience using these acquired schema.

According to Piaget (1951/1967), imitation in young infants involves the immediate and faithful reproduction of actions which the child has witnessed. Such imitation obviates the need for mental representation of action. However, in older infants, forms of imitation are entirely mediated by internal, mental representations of the actions witnessed. The development of imitation skills is pertinent to Piagetian theory given the close correspondence between constraints on forms of imitation and the child's representational status. Piaget took the view that imitation, as with all aspects of development, is rooted in sensorimotor action during the first 18 months of life. The emergence of the symbolic function at the end of this period enables children to internalise and form mental representations of action. This transition therefore corresponds with the capacity for more sophisticated forms of imitation such as deferred imitation. Deferred imitation involves the child reproducing a modelled act after a substantial interval of time. McShane (1991) raises an objection to Piaget's view of representation as a theoretical construct and deferred imitation as an operational measure of its emergence. Fundamentally, McShane argues that like a number of Piaget's claims, the denial of representation to the sensorimotor infant may be overcautious. Furthermore, the use of deferred imitation as the defining property of imitation based on mental representation may reflect empirical convenience rather that genuine theoretical validity.

Rather than work backwards from a empirical construct to a theoretical one McShane (1991) advises the search for unambiguous evidence for symbolic representations should proceed on a firm basis of theoretical definitions of representation. The process of imitation can be viewed as three distinct serial processes represented schematically in Figure 5-1

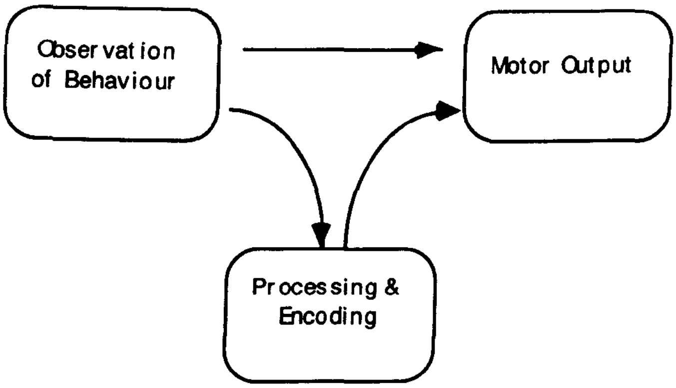


Figure 5-1: Schematic diagram of imitation processes

Prior to the emergence of symbolic representations imitation is simply a complex reflex action and follows a direct path from behavioural observation to motor output. Piaget argued that in the case of deferred imitation, the delay between observation and motor response demanded that perceptual inputs be stored in the interim as abstract representations. While it is clear that deferred imitation must imply some representational coding, Piaget may have been wrong to deny the existence of this path prior to the emergence of deferred imitation.

The onset of the deferred imitation is seen from a Piagetian point of view as an important indicator of the child's ability to form symbolic mental representations. Imitation in general has a clear status both in representational terms and as a consequence of its role in early development. In order to understand the role which imitation may play in development we need to have a clear understanding of the timing of its development in relation to other developmental processes and transition. The following section begins with a Piagetian account of imitative development and subsequently introduces some recent evidence which is contrary to this view.

5.2.2 The chronology of Piagetian development

According to Piaget, the child's capacity to imitate is constrained, during the period of sensorimotor development, by a lack of ability to store and process mental representations. Imitation in the first 18 months proceeds from a circumscribed set of reflex actions which are subsequently elaborated alongside sensorimotor schemes. Imitation is initially absent, if we discount a few reflex actions, and progresses through to sporadic imitation at stage II of sensorimotor development. By stage III, the child is able to imitate sounds she has already produced and respond imitatively to movements which are both within her repertoire and which she herself can observe. The requirement for the child to observe her own attempts at imitation precludes both facial imitation and tongue protrusion. Observations of tongue protrusion, as early as stage III, are discounted by Piaget as 'pseudo imitation', maintained only in response to intensive and sustained training. By stage IV the child is able to imitate hidden movements and attempts to imitate new models of sound and movement. Piaget describes Jacqueline's inaccurate but consistent attempts at imitation of tongue protrusion at this stage. More systematic attempts at imitation are being made by stage V with successful imitation of new and complex schemes. At the final stage of sensorimotor development, stage VI, children develop a capacity for deferred imitation, imitation of more complex models, and imitation of objects.

Piaget's view of imitation as a stagewise process concordant with advances in general sensorimotor development is not supported by Uzgiris and Hunt (1975). Although empirical evidence on imitation supports the sequential progression outlined by Piaget, there is little evidence for correspondence with general sensorimotor development.

Uzgiris and Hunt claim that children show widespread developmental divergence between domains such as means-ends, object permanence and imitation. However, more damaging evidence for Piaget's theoretical approach to imitative development is provided by studies of neonatal imitation and evidence for deferred imitation prior to 18 months.

5.2.3 Challenges to the Piagetian view: neonatal imitation and deferred imitation

Recent advances in empirical paradigms have led to a greater understanding of the representational capacities of young and new-born infants. In chapter 3, it was suggested that young infants possess quite sophisticated representations of the objects well before Piaget attributed any representational capacity to them. There is growing evidence that in terms of imitation, children's early capacities may have again been underestimated.

Meltzoff and Moore (1977) presented evidence to suggest that infants as young as nine days old have the capacity to imitate simple facial gestures such as lip protrusion, tongue protrusion, and mouth opening. Piaget denied that children can imitate such gestures accurately until they reach 12 months. This counter-evidence, seen as an 'innate basis for facial imitation' (Meltzoff, 1990) is damaging for the Piagetian view of imitative development. More recent research has shown that even new born babies may have a more general capacity for imitation of simple facial expressions (Meltzoff & Moore, 1989). However, Meltzoff and Moore's (1977) results have been criticised as methodologically dubious and while the findings have been replicated (Field, Woodson, Greenberg & Cohen, 1982; Meltzoff & Moore 1983), other studies have failed to do so (McKenzie & Over, 1983; Hayes & Watson, 1981). Kaitz, Meschulach-Sarfaty, Auerbach and Eidelman (1988) suggest that the neonate's capacity for imitation may be limited to tongue protrusion. The information processing requirements of translating perceptual representations into motor responses would seem to be taxing for new born infants. However, Meltzoff and Gopnik (1989) suggest a more simple mechanism for early imitation, active intermodal mapping (AIM). This process constitutes a supramodal, or modality free representational basis common to both perceptual input and motor output. The modality free structure of representations obviates the need for translation, and the consequent processing demands.

A number of authors have suggested that neonatal imitation as demonstrated by Meltzoff and Moore (1977) may be qualitatively different from later forms. Jacobson (1979) finds evidence that tongue protrusions can be elicited in response to the occilating motion of a pen in a tube and therefore have more in common with 'fixed action patterns' (Tinbergen, 1951) than genuine imitation. Other researchers have suggested that the developmental characteristics of neonatal imitation such as a reduction in frequency with age (Abravnel & Sigafoos, 1984; Maratos, 1982) is consistent with a transfer of control from sub-cortical to cortical mechanisms (Vinter, 1986). Neonatal imitation may be therefore under sub-cortical control as opposed to later cortical imitation. Regardless of neural mechanisms, neonatal imitation may be distinguishable in representational terms from the imitation observed in older infants.

Further problems for the Piagetian model come from studies showing infants' precocious aptitude for deferred imitation of novel acts. Piaget argued that deferred imitation required the representational capacities which characterise stage VI of sensorimotor development. Deferred imitation entails imitation of a novel act following a delay. The act must be one which children have previously seen but have not themselves performed. A capacity for deferred imitation was Piaget's acid test for the existence of mental representation in infancy. However, a growing body of research suggests that infants as young as 14 months, well before the transition to stage VI of sensorimotor development, have a capacity to produce acts of deferred imitation (Meltzoff, 1989; Meltzoff, 1988; Heimann & Meltzoff, 1996). Meltzoff (1988) modelled actions with specially constructed toy equipment. For example, one action involved the experimenter touching his head against a 'light box' and thus activating a light. When presented with a sequence of these toys, and with delays of up to one week, 14-month-old children were able to reproduce the action at a higher frequency than a control group who had not witnessed the model. Children were denied the opportunity to practice the action immediately following the model and hence the act involves deferred imitation.

The apparent ability of children as young as 14 months to engage in deferred imitation suggests the capacity for mental representation. Such evidence for abstract internal representations of actions may have implications for representational development generally (Meltzoff, 1990; Heimann & Meltzoff, 1996). It is often claimed that Piaget underestimated the representational capacities of young children, as was discussed in relation to both object permanence (Chapter 3) and language (Chapter 4). Findings of precocious representational capacity across a number of domains may simply reflect the emergence of a generalised representational capacity well before the 18 month watershed proposed by Piaget.

However, if mental representation occurs well before 18 months then reliable developmental features which emerge at this age cannot be attributed to a shift in representation per se as Piaget would argue. However, at around 18 months a number of social and linguistic features emerge which may reflect a shift in the *form* of representation. Meltzoff (1990) characterises this representational shift as a transition from *empirical* to *hypothetical* representations. Hypothetical representations allow the child to entertain simultaneous representations of actual and hypothetical states of affairs. Meltzoff argues that this general shift in representational capacity enable the child to entertain the proposition, 'as if' in play, language and thought processes. In play this emerges as a capacity for pretence and in language as a use of terms which contrast actual and possible events such as the use of 'gone'.

5.2.4 Summary

Imitation according to Piaget reflects a fundamental component of infant intelligence, that of accommodation. The capacity of the child to adapt internal schema in the light of experience of new models is complemented by a capacity to assimilate or apply these schema to situations. Piaget believed that imitation during the early sensorimotor period was strictly limited to actions which children could observe themselves making and had already produced. Later children develop the capacity to imitate new models and actions which they could not observe themselves making. However, the most crucial change in the representational status of imitation corresponds, according to Piaget, with a capacity for deferred imitation. Deferred imitation involves the internalisation of imitation as a mental representation of action which is expressed after a substantial delay. In contrast, recent evidence has questioned the limitations which Piaget has imposed on children's early imitation and suggests that imitation of facial gestures is relatively intact even in neonates. Furthermore, children of 14 months appear to be able to produce acts of deferred imitation well before the Piagetian watershed for 'representational thought'.

A number of empirical and theoretical questions have arisen from studies of neonatal and deferred imitation. There is some debate over the possibility that neonatal imitation may be distinguished from similar forms of imitation which emerge later in development (Jacobson, 1979; Abravnel & Sigafoos, 1984; Maratos, 1982). Similarly, studies of deferred imitation raise questions about whether deferred imitation deserves a representational status distinct from immediate imitation (McShane, 1991). It may be that deferred imitation simply reflects an increase in the capacity to remember actions rather than a representative capacity per se (Meltzoff, 1990). The corollary of these claims is that imitation, deferred or immediate, has a representational basis.

In summary, it appears that the use of imitation as a means of acquiring representations may be available to children much earlier that the 18 month transition as proposed by Piaget. The 18 month transition may not reflect the onset of representation but a shift in its nature. The development of representation in typically developing children may therefore be characterised by two general developmental transitions, a primary transition leading to the capacity for representation followed by a second general change in the form of representationalcapacities.

Evidence presented thus far is consistent with a domain general view of representational development. Some would argue conversely that representational development may be a domain specific process (Karmiloff-Smith, 1992/1995; Fodor, 1983, 1989). However, as was argued in chapter 2, the rapid and coherent development in typical children may disguise any dissociations in representation which exist between domains. In contrast, children from atypical populations provide a powerful test of the domain general view. Imitation as an early indicator of representational capacity is in this respect a useful empirical tool and any discrepancy between imitative representations and representations in other domains would add support to a domain specific view of representational development.

The subsequent section addresses the development of imitation and its relationship to other domains in children with Down's Syndrome. Furthermore, the evidence for imitation as a relative strength in children with Down's Syndrome will be discussed in terms of the role for imitation in development.

5.3 The development of imitation in children with Down's Syndrome

The status of children with Down's Syndrome as an atypical population with the consequent propensity for an anomalous developmental profile may prove informative in the light of evidence for early imitation and its relationship to other domains of representational capacity. A number of questions surround the timing of the emergence of representational imitation and the scope for imitation to impinge on other capacities such as play via a common representational framework. Given suggestions that imitation and social engagement represent a consistent developmental strength in children with Down's Syndrome, the role of imitation in development and its underlying representational basis is particularly pertinent.

Children with Down's Syndrome are often described, somewhat stereotypically, as being 'sociable' (Gibbs & Thorpe, 1982). However, empirical evidence for this is equivocal and depends upon the particular measure of social behaviour and the comparison group chosen (Beeghly, Weiss-Perry & Cicchetti, 1990; Krakow & Kopp, 1983; Sigman &

Ungerer, 1984). The perceived strength of social engagement in children with Down's Syndrome may reflect a tendency towards imitation which is often seen as indicating sociability and consequently rewarded (Ruff & Rothbart, 1996).

Imitation or 'mimicry' is very much part of the Down's Syndrome folklore and a number of claims have been made regarding imitation as a particularly strong feature of this population. Shuttleworth (1900) commented that 'powers possessed by such children [with Down's Syndrome] of mimicry are often extraordinary' and Down (1866) wrote 'they have considerable powers of imitation, even bordering on being mimics'. Both Down (1866) and Crookshank (1931) favoured an atavistic explanation for the propensity of children with Down's Syndrome to imitate. Many researchers take the view that an imitative strength is likely to be a consequence of having Down's Syndrome, or that it is used as a strategy to compensate for weaknesses. Benda (1946) saw the propensity for imitation as a result of a prolonged and exaggerated typical developmental phase. Bilovsky and Share (1965) suggested a compensatory view of imitation, as a supplement to deficits in the auditory and verbal domains. Blacketer-Simmonds (1953) argued similarly that imitation was a form of perseveration and over-compensation. Other authors appeal to the drive and impulse characteristics of Down's Syndrome in an attempt to understand imitation (Blessing, 1959; Sternlicht & Wanderer, 1962).

Gibson (1996) remarks that regardless of the imitative propensity of the syndrome one needs to establish to what extent this propensity is unique, inherent, merely artifactual, useful, or exploitable, or a stereotypic novelty. Barr (1904) argued that superior short term recall and rote memory formed the basis for the imitative talent of children with Down's syndrome. Recent evidence suggesting that children with Down's Syndrome have strengths in visual short-term memory (Pueschel, Gallagher, Zartler, & Pezullo, 1987) and in the imitation of hand movements (Hodapp, Leckman, Dykens, Sparrow, Zelinsky, & Ort, 1992; Neeman, 1971) is generally supportive of Barr's view. Neeman (1971) reports that motor imitation is a superior teaching tactic to directed motor training. Neeman's study reports the performance of 33 children with Down's Syndrome and 66 children with learning disabilities on the Purdue Perceptual-Motor Survey. Children with Down's Syndrome scored lower than the children with learning disabilities on 18 out of 19 items but scored higher than the learning disabled group on 'imitation of movement'. More recent studies by Hodapp et al. (1992) and Pueschel et al. (1987) report that children with Down's Syndrome have a particular strength in sequential imitation of hand movements. The apparent relative strength for imitation in children with Down's Syndrome, while often viewed in comparison to other cognitive skills, is rarely investigated from a representational perspective. Imitation clearly has some representational basis and any disparity between imitation and other cognitive skills can tell us something about the nature of common or distinct representational requirements which such skills require.

Rast and Meltzoff (1995) examined the performance of 48 infants with Down's Syndrome aged between 20 and 43 months on both object permanence and deferred imitation tasks. Children were divided into two groups, 'high-OP' and 'low-OP', on the basis of performance on object permanence tasks. The deferred imitation task required children, having observed a novel act with one of six experimental objects, to reproduce the act after a five minute delay. Rast and Meltzoff report an asynchrony in the development of deferred imitation and object permanence in that they found no significant difference between high-OP and low-OP groups in terms of performance on the deferred imitation task. The claim for a developmental asynchrony rests on the Piagetian assertion that deferred imitation is not possible until the child has a representational basis and furthermore that this representational basis is not available until stage VI of sensorimotor development. Children with Down's Syndrome in Rast and Meltzoff's study appear to be capable of deferred imitation at stage V. Such findings lead to several theoretical conclusions concerning children with Down's Syndrome specifically and the development of representation generally.

The most straightforward conclusion to be drawn from Rast and Meltzoff's study is that the ability to carry out deferred imitation prior to stage VI is contrary to Piaget's view of sensorimotor development as a domain general process. It would also appear that mental representation is evident in imitation prior to the representation of hidden objects suggesting a degree of dissociation in the representational basis.

However, there are a number of criticisms which can be levelled at Rast and Meltzoff's claims. Firstly, the study did not include a control group and consequently the asynchronous development may not be a Down's Syndrome specific phenomenon. A number of studies have reported precocious deferred imitation in typically developing children as early as 14m which suggests that 'asynchrony' is not a specific feature of Down's Syndrome. Secondly, Rast and Meltzoff's assertion of asynchrony is based on comparison of tasks which have very different cognitive demands on children. Wishart (1997) argues, for example, that Rast and Meltzoff may have underestimated the object permanence skills of children with Down's Syndrome by adopting a particular protocol in assessment of search skills. Clearly, any dissociation between performance on imitation and object permanence tasks may reflect performance factors irrespective of the representational demands.

Thirdly, with respect to the representational demands, and in a strictly Piagetian sense, Rast and Meltzoff's data do suggest asynchrony. However, a number of studies have suggested that Piaget may have been wrong about the representational status indicated by children's performance on standard object permanence tasks (see Chapter 3). Children appear to be capable of representing objects well before they can pass stage VI object permanence tasks. Thus the discrepancy between children's performance on imitation and object permanence tasks does not suggest an unequivocal discrepancy at the representational level.

5.3.1 Imitation as a process: is imitation a developmental strength or weakness?

While many early studies of children with Down's Syndrome speculate that a propensity to imitate may be as a result of, or compensation for, other cognitive weaknesses, few studies have directly compared children's imitation to performance in a theoretically related domain. Rast and Meltzoff's (1995) study is one exception which compares the underlying representational capacity implicated in high level object permanence and deferred imitation. Piaget hypothesised that both deferred imitation and the representation of objects were limited by common representational constraints. The apparent disparity between the emergence of deferred imitation and high level object permanence are certainly counter to this strict Piagetian hypothesis.

While Rast and Meltzoff identify an area worthy of investigation their study does not suggest a fundamental distinction in representational terms between object permanence and imitation. Furthermore, their study does not allow us to conclude that such a discrepancy is a unique strength in the Down's Syndrome population. The question of a representational discrepancy and the uniqueness of this discrepancy to the Down's Syndrome population is addressed in subsequent empirical work (Chapter 11). However, despite the weakness of Rast and Meltzoff's evidence it would appear to be worth considering imitation as a potentially genuine and unique strength in children with Down's Syndrome.

5.4 Summary

Referring to our initial discussion concerning the basis for imitation in typically developing children it is certain that some form of representation is implicated in imitation. Neonatal imitation may proceed via a different mechanism from later forms of imitation but it would appear that some form of 'representative' imitation is evident well before children reach the 18 month transition proposed by Piaget. The domain general view of representation depends on the extent to which this early imitation is matched by similar representational capacity in other domains.

Evidence from imitation and other representational capabilities in atypical populations may support or refute claims for a domain general representational capacity. If imitation clearly emerges as a strength in children with Down's Syndrome then this would force us to address the extent to which imitation could reflect a common representational capacity.

This chapter began by emphasising the pervasive nature of the imitation process across a number of developmental domains. If a capacity for imitation was to emerge as a strength within the Down's Syndrome population we must ask to what extent it would influence the course of development within related domains such as language and sensorimotor development. While imitation is, to a certain extent, fundamental to the development of a number of skills such a propensity in excess could lead to an imbalance in development. Piaget referred to the relationship between assimilation and accommodation as 'intelligent' only in the case where such processes were present in equal measure. Piaget argues that an imbalance over a period of time would be maladaptive from the point of view of development. We have mentioned that Piaget regarded imitation as an extension of accommodation and therefore an excess of imitation could be seen as maladaptive in Piagetian terms. Piaget referred to the lack of co-ordination or comprehension which would result from the primacy of accommodation or imitation. This primacy of imitation refers to a tendency to continually incorporate or modify existing schemes or representations on the basis of new experiences. The corresponding lack of assimilation would result in a failure to apply such schemes in new contexts or with new objects. The acquired schemes incorporated through imitation would fail to yield greater understanding because such schemes could only serve to recreate the action in a context bound situation with the same object. Furthermore, accommodated schemes would not be co-ordinated in that schemes would refer to distinct objects and contexts. Learning, dominated by imitation, would therefore fail to be generalised.

Beyond the Piagetian view of development, many would see development as a process involving an initial acquisition of skills followed by some form of internal and external consolidation and reorganisation (Karmiloff-Smith, 1992/1995). The success of the acquisition process reflected in imitation would therefore serve to highlight a corresponding deficit in the consolidation, strengthening and internal reorganisation of skills. Such a state of affairs is evidently counter-productive to development. New skills would tend to be learned by observation and would not then be generalised to other tasks or situations. There is some evidence for the failure of children with Down's Syndrome to generalise learning experiences (Duffy & Wishart, 1994) and to consolidate learned experiences (Wishart, 1996a; Karmiloff Smith, 1992/1995). A number of researchers have characterised the learning style in children with Down's Syndrome as being deviant (Wishart, 1996a; Rast and Meltzoff, 1995). It is argued here that observed differences in the learning style and performance of children with Down's Syndrome may reflect a relative strength in imitation rather than particular weaknesses elsewhere.

As we have noted, imitation represents the accommodation pole of the Piagetian continuum between assimilation and accommodation. According to Piaget, play comprises the opposite pole, a continuation of assimilation. In the following chapter we consider play as a developmental process and its relationship to imitation.

Chapter 6

The Development of Representation: The Role of Symbolic Play

In the previous chapter, imitation was considered as a representational process. The evidence suggesting it is a relative strength in children with Down's Syndrome was also reviewed. In this chapter, the development of symbolic play is considered in terms of its characteristic representational qualities. Given the emphasis on imitation as a developmental process this chapter considers the relationship between play and imitation as complementary developmental processes.

This chapter will first discuss the development of symbolic play from the perspective of typically developing children. The Piagetian view of play and imitation will be discussed in relation to the developmental role of these processes. The representational basis for play will subsequently be introduced with reference to links with an awareness of mental states, or theory of mind. The link between symbolic play and theory of mind has emerged largely from work with children with autism. The development of symbolic play will therefore be discussed from the perspective of atypical populations, and specifically children with autism. The concluding discussion will address symbolic play development in children with Down's Syndrome with reference to the motivational and broadly social components of play. The relationship between the development of symbolic play and representational development in general will also be considered.

6.1 Symbolic play as representation

Symbolic play can be seen as a 'window into the representational world of the infant' (Bergman & Lefcourt, 1994) and provides us with an opportunity to gauge children's ability to engage with and manipulate symbolic representations. A frequently cited example of symbolic play is a child's use of a banana 'as if' it were a telephone. It is the 'as if', non-literal, or simulative quality of symbolic play in this example which distinguishes symbolic from functional acts (Garvey, 1977). Symbolic play encompasses a number of acts which can be regarded as representational in the sense that the acts distinguish between the 'signifier' and the 'signified'. In contrast, functional acts involve the use of miniature or lifelike copies of real objects while the requirements of symbolic play are more abstract. Leslie (1987) suggests the following as indicating symbolic play: object substitution (using one object to represent another), attribution of absent or false properties (pretending that a cold drink is hot), and referring to an absent object as if it were present (pretending an empty cup contains a drink). The symbolic act of pretending a banana is a telephone can thereby be distinguished from the functional act involving a miniature or toy telephone in the same procedure. This definition of symbolic play is intended to isolate a capacity for representation in play from play acts which could be learned or copied directly from adults (Huttenlocher & Higgins, 1978).

The symbolic nature of play which emerges in pretence at around 18 months is fundamental to its role as an indicator of representational status. Furthermore the relationship between representation in play, linguistic representation, and the representation of mental states has elevated the status of symbolic play as a focus for empiricalinvestigation.

6.2 The development of symbolic play in typically developing children

In the previous chapter, it was noted that imitation was regarded by Piaget as an extension of accommodation(Piaget, 1951/1967). In contrast, symbolic play was regarded as an extension of assimilation and was referred to as 'ludic' assimilation by Piaget. Piaget saw symbolic play in the extreme as an expression of pure egocentric thought. Piaget gives an example of a child placing a shell on box as if it were a cat on a wall, and comments that, such actions do not reflect any attempt at understanding, but are carried out by the child, 'merely for the pleasure of combining these real objects to suit his whim' (p.281).

6.2.1 Play and imitation as developmental processes

The relationship between imitation and play, according to Piaget, characterised the distinction between assimilation and accommodation. While imitation involves the incorporation of new schemes into the child's existing repertoire, play is the application of existing schema to the world. According to Piaget, imitation and symbolic play therefore comprise opposite poles of the equilibrium between assimilation and accommodation. Play represents the primacy of assimilation over accommodation while imitation reflects pure accommodation. Before the emergence of representational thought, Piaget (1951/1967) believed that play and imitation developed separately and were 'to some extent antithetic' (p.89) during the sensorimotor stage. With the emergence of representational thought, imitation becomes internalised as mental representation and thus play and imitation come to depend on common underlying representations.

Despite the representational codependence of imitation and play, Piaget argued that the emphasis on assimilation or accommodation distinguishes between the two behaviours. Imitation as an extension of accommodation involves a transformation of existing schemata to incorporate a new model. New schema thus formed are 'susceptible to immediate or subsequent reconstruction' (p.103). This subsequent transformation can either be adaptive or 'ludic' depending upon the nature of the subsequent assimilation process. 'Ludic' assimilation characterises symbolic play and therefore allows the child to express models in novel contexts and with unfamiliar materials. Symbolic play, therefore reflects the absence of accommodation and a consequent disregard for the object in preference to the expression of thought.

The functional role for symbolic play in development stems from its relationship to 'intelligence' as defined by Piaget. Intelligent action in Piagetian terms requires an established equilibrium between assimilation and accommodation in which the child's actions remain concerned with the properties of the real object. The developmental role for symbolic play is therefore enshrined in the assimilation process.

6.2.2 The Piagetian chronology of development

Piaget argued that like many other representational capacities, symbolic play reflected the emergence of the capacity for representational thought at around 18 months. Piaget believed that play during the sensorimotor period was limited to sensorimotor practice. Subsequent to the emergence of pretend play at around 18 months, children are hypothesised to develop games with rules which gradually supersede pretence as a dominant form of play. Overall therefore, symbolic play emerges towards the end of the second year, increases over the following three to four years and then begins to decline in favour of rule based games.

Evidence for a Piagetian chronology in the emergence is symbolic play is relatively strong. Sensorimotor activity with single objects declines between 7 and 30 months and this decline is met with a corresponding increase in symbolic play. The onset of symbolic play is relatively abrupt and increases in frequency in children between 12 and 30 months (Fein, 1981). Despite the prevalence of references to symbolic play in the child development literature the frequency of symbolic, as opposed to other forms of play remains quite low and reaches a maximum of around 17% in pre-school children and 33% in nursery groups (Rubin, Watson & Jambor, 1978)

The emergence of symbolic play was thought by Piaget (1951/1967) to correspond with the emergence of the semiotic, or symbolic function characterising the emergence of mental representation. Children's play in the second year of life is therefore regarded as increasingly representational. Piaget characterises the representational qualities of play in terms of the child's use of schemes '(i) instead of using them in the presence of objects to which they are usually applied, he assimilates to them new objectives unrelated to them from the point of view of effective accommodation, (ii) these new objects... are used to mime or evoke the schemas in question' (p. 97). Piaget offers the example of Jacqueline pretending to sleep while holding a cloth, a coat collar, or a donkey's tail, rather than a pillow, as an example of emergent pretend play.

The developing capacity for symbolic play is characterised by three trends; *decentration*, *decontextualisation*, and *integration*. Decentration refers to the trend for play to move from being self-directed to becoming increasingly other-directed. Decontextualisation refers to the capacity for the use of symbolic as opposed to realistic objects in acts of pretence. Integration refers to children's capacity to concatenate a number of related play acts into a coherent sequence such as 'going to the shops'.

Evidence for such sequential trends in the development of play is relatively strong. Watson and Fischer (1977) report a decline in self-directed behaviour between 12 and 30 months and a corresponding increase in doll-directed behaviour over the same period. Additionally Watson and Fisher note an increasing trend for dolls to be used as active agents in play rather than as passive recipients. With respect to object substitution, Watson and Fischer report that children predominantly use a realistic doll in play between 14 and 19 months but are subsequently able to treat a block as a doll in symbolic acts. By 24 months, children are able to use two unrealistic objects in a combined act (Watson & Fischer, 1977; Fein, 1981).

The sequential properties of symbolic play receive additional support from Nicholich (1977) who observed the emergence of play in five typically developing children. Nicholich classified the emergence of play as a five level ordinal scale. The scale begins at 'presymbolic schemes' in which children demonstrate knowledge of an object's function in brief gestures, for example by touching a comb to their hair. The first evidence of pretence, according to Nicholich, emerges at level 2, with simple pretend acts such as sleeping, eating, drinking etc. The pretence at level 2 is conditional upon single acts being performed with inadequate materials, such as an empty cup, or outside their normal context. The third level of play involves single actions directed at others, e.g. the child's mother, and acts which adopt another person's role, e.g. driving a car. The final two levels of play involve the combination of numerous symbolic acts which at the final level are demonstrably planned in advance.

A similar ordinal scale is proposed by Belsky and Most (1981) and is based on a cross-sectional study of 40 infants. Play is characterised as progressing from self directed single-scheme play to other-directed single-scheme acts. At subsequent stages, according to Belsky and Most, children begin to perform 'substitution' acts in which 'meaningless' objects are used in a creative or imaginative manner. Higher levels of play involve the progression towards elaborate sequences with multiple object substitutions such as giving a stick a 'drink' with a seashell. Belsky and Most's requirement for substitution of objects and Nicholich's use of criteria for inadequate materials support the Piagetian trend towards decontextualisation in play and reflect Leslie's distinctions between functional play and pretend play (Leslie, 1987). A recently introduced test of pretend play, the ToPP, (Lewis & Boucher, 1997) emphasises the significance of object substitution in pretend play. In contrast to other tests of so-called symbolic play such as the Lowe and Costello test (Lowe & Costello, 1988) the ToPP requires children to progress beyond the use of realistic objects in play and use 'junk' objects in a decontextualised manner.

While the Piagetian chronology of pretend play development is well supported, the representational requirements of pretend play are frequently disputed. In contrast to Piaget's view of symbolic play as a reflection of a general emergent capacity for symbolic representation (Piaget, 1951/1967), some researchers view play as a domain specific representational capacity (e.g. Leslie, 1987). In the following section alternatives to Piaget's account are discussed in terms of representational links with other developmental domains.

6.2.3 Challenges to the Piagetian view: symbolic play and representational development

Piaget suggested that both play and language were dependent upon the semiotic function, a domain general capacity for symbolic thought. In contrast, Vygotsky believed that the development of substitution in pretend play was instrumental in the development of linguistic representation. Vygotsky saw the emergent distinction between substitute object and real object as precipitating a shift from things as objects of action, to things as objects of thought (see Fein, 1981).

Many contemporary views of representational development suggest a more modular, circumscribed structure to symbolic play development. Furthermore, symbolic play is often seen as related in representational terms to children's understanding of mental states. In the current section, contemporary views of representational development are discussed in relation to symbolic play and other domains of development.

Both Leslie (1987) and Perner (1988/1991) acknowledge that there is a watershed at 18 months in respect of children's ability to engage in pretence. However Leslie, Perner and Piaget have contrasting views of the representational nature and developmental properties of early pretence. Leslie argues that the onset of pretend play at 18 months corresponds to an ability to decouple primary representations, objects as themselves, from secondary representations, objects as targets for pretence. In Leslie's terminology the act of pretending that a banana is a telephone is one of drawing a distinction between the representation of the banana as a banana, the primary representation, and the banana as a telephone, the secondary representation. Leslie argues that the capacity to form secondary representations, or meta-representation, allows children to 'tamper' with the secondary representation during pretence while maintaining a veridical representation of reality. Leslie suggests furthermore that the structural distinction between propositional attitude, e.g. 'pretending that X', and propositional content, e.g. 'this banana is a telephone', is a fundamental component of children's capacity for meta-representation and pretence.

Leslie's views, at face value, correspond closely to Piaget's view of the emergent symbolic function but differ widely in terms of its origin. Leslie, like Fodor (1983), argues that the structural properties of pretence are both domain specific, modular, and innately constrained, rather than built on experience of action. What is striking about Leslie's account is that it posits the existence of conceptual structures prior to linguistic expression. The distinction between propositional attitude and propositional content presupposes distinct concepts of agent, event and object. The Piagetian view of development strongly denies that such representational concepts could be innately specified.

Perner (1988/1991) acknowledges that some form of transition takes place at 18 months. However, he suggests that this transition does not involve a increased capacity for representation per se but the capacity to hold simultaneously two alternative world views. Thus, according to Perner, the 18 month old does not distinguish between propositional attitude and propositional content, as Leslie would argue, but instead maintains two alternative versions of propositional content. The representational shift according to Perner occurs at around four years and corresponds with the capacity to understand mental states, referred to as a theory of mind. Perner suggests that prior to this transition the child does not understand representation in the sense of being explicitly aware of its existence. This capacity for meta-representation, according to Perner, is not available until the child is four years old. In contrast, Leslie attributes this capacity to the 18 month old child.

The theoretical positions adopted by Piaget, Leslie and Perner with respect to representational development can be compared and contrasted according to the domain specificity of the structure of pretence and the status of pretence as a representational capacity. Does symbolic play reflect a domain general capacity (à la Piaget and Perner), or is pretence a domain specific capacity as Leslie would argue? Furthermore does the emergence of pretence reflect a understanding of representation? Leslie and Piaget would agree it does while Perner suggests this capacity does not emerge until four years.

Much of the current research emphasis on pretend play is based on its relationship to later understanding of mental states in both linguistic and behavioural domains. Perner views pretence as distinct from the behavioural and linguistic encoding of mental states. In contrast Leslie sees a 'deep isomorphism' between the structure of pretend play and children's mental state awareness. Much of the crucial evidence on the representational status of pretend play and theory of mind has been gleaned from atypical populations, and specifically children with autism. The following discussion of symbolic play will focus on empirical evidence from children with autism and children with Down's Syndrome.

6.2.4 Symbolic play in atypical populations: evidence from children with autism

The link between the development of symbolic play, performance on theory of mind tasks, and use of mental state language, has been extensively investigated. The reason for the interest in these links stems from studies of children with autism. Children with autism, in contrast to typically developing children, tend to fail tasks requiring an understanding of the mental states of others or changes in their own mental state, so called theory of mind tasks (TOM). TOM tasks require children to use mental states as a means of understanding and predicting behaviour. Tasks such as the false-belief task (Baron-Cohen, Leslie & Frith, 1985), the Smarties task (Perner, Frith, Leslie & Leekham, 1989) and strategic deception tasks (Russell, Jarrold & Potel, 1991) are generally failed by typically developing three-year-olds but passed by four-year olds. Furthermore, children with autism appear to be dramatically delayed in performance on theory of mind tasks and often fail such tasks until they have a developmental age of seven to eight years (Happé, 1995).

The specificity of this apparent TOM deficit in autism has prompted a flurry of theoretical explanations for its aetiology. One robust finding is that children with autism appear to engage in significantly less symbolic play than both typically developing children and children with learning disabilities matched for developmental age (Baron-Cohen, 1987; Jarrold, Boucher & Smith, 1991). The suggestion that both pretend play and TOM are selectively impaired in autism has led a number of authors to suggest a common aetiology (Leslie, 1987). Leslie argues that symbolic play and theory of mind tasks depend on the same representational components. Furthermore, Leslie, argues that this representational capacity is normally present at birth. Typically developing children of three-years-old reliably fail the false belief task but engage in pretend play. How could such tasks reflect the presence of a common innate representational basis? Leslie argues that children fail false belief tasks in this case, not because they lack a capacity for meta-representation, but because they lack the necessary information processing capacity (Leslie & Thaiss, 1992).

Common to both Leslie and Perner's account of symbolic play is the ability at 18 months to form two representations of an object which thereby facilitates pretence. Evidence that children do not pass false belief or TOM tasks until four years of age weakens Leslie's account and supports Perner's view of TOM as distinct from play. Evidence, from autism, for a link between early symbolic play and later measures of mental state understanding supports Leslie's view that both symbolic play and explicit knowledge of mental states are reliant on the same capacity for meta - representation.

However, evidence from Lewis and Boucher (1988) casts doubt on Leslie's views of a common deficit and a common representational basis for play and TOM. Lewis and Boucher argue that children with autism do engage in pretend play if play is prompted or elicited. The deficit does not therefore appear to be a problem with representation per se, but a deficit in generating spontaneous play.

While much of the evidence for the coincidence of symbolic play and TOM deficits has been gleaned from studies of children with autism, children with Down's Syndrome have frequently formed a comparison group in these studies. Such studies typically report lower levels of symbolic play in children with autism than in children with Down's Syndrome (e.g. Sigman & Ungerer, 1984; Baron-Cohen, 1987; Riguet, Taylor, Benaroya & Klein, 1981). The evidence for specific deficits in children with autism therefore relies upon the assumption of relative coherence in the development of children with Down's Syndrome. Children with Down's Syndrome appear to have been seen as a convenient comparison group due to their aetiological homogeneity and ostensibly typical developmental profile. However, on close examination, it appears that children with Down's Syndrome may not show a typical developmental progression in symbolic play thereby casting doubt on the validity of many comparisons. Furthermore, recent research has suggested an increased prevalence of autism within the Down's Syndrome population (Howlin, Wing & Gould, 1995).

The status of symbolic play development in atypical populations is central to understanding the representational status of symbolic play. Evidence from autism suggests a close correspondence between early symbolic play and later awareness of mental states. Furthermore, the relationship between symbolic play and TOM suggests a common representational basis. The development of symbolic play in children with Down's Syndrome therefore warrants scrutiny, not least because of the indirect links with research in the autistic population.

6.3 The development of symbolic play in children with Down's Syndrome

There is widespread evidence which suggests that the development of symbolic play in children with Down's Syndrome proceeds in a sequence similar to that of typically developing children (Beeghly, Weiss-Perry & Cicchetti, 1990; Hill & McCune-Nicholich, 1981; Motti, Cicchetti & Sroufe, 1983). Beeghly et al. (1990) examined age related changes in the development of symbolic play in older and younger cohorts of children with Down's Syndrome with developmental ages of 23 months and 48 months respectively. Beeghly et al. found similar proportions of object and social play in children with Down's Syndrome compared to age matched controls. The proportion of overall play time deemed to be symbolic play was significantly greater in the older cohorts for both the Down's Syndrome and the typically developing group. This finding is consistent with trends observed in typically developing children (Belsky & Most, 1981). Further comparisons of play types revealed few differences between children with Down's Syndrome and typically developing children matched for developmental age. The one exception to this was a significantly greater frequency of manipulative play in the younger cohort of children with Down's Syndrome.

While global measures of duration of symbolic play reveal few differences between children with Down's Syndrome and typically developing children, differences do emerge when one compares the frequency of play acts within each group. There is growing evidence to suggest that the play of children with Down's Syndrome may be stereotypical, repetitive and rigid (Kopp, 1990; Kopp, Krakow & Johnson, 1983; Krakow & Kopp, 1982, 1983; Mundy & Kasari, 1990). Krakow and Kopp (1982) suggest that children with Down's Syndrome, in contrast to typically developing children, often repeat sequences of play such as 'feeding baby', in the same order rather than elaborate upon them.

Krakow and Kopp (1983) report data from a study of 38 children, 12 children with Down's Syndrome, 13 typically developing children and 12 children with learning disabilities of unknown aetiology. The mean developmental ages of the groups were between 27 months and 29 months. Krakow and Kopp (1983) report a significantly higher proportion of repetitive, regressive and inflexible play in the group of children with Down's Syndrome in contrast to both control groups. Once again the authors observed repetitive sequences of bathing-feeding-bathing-feeding during doll play with no elaboration or change in the play sequence. Kopp (1990) describes a play sequence in which a child with Down's Syndrome repeated the same scheme of play eight times. In a similar study of younger children (developmental age 17 months) Krakow and Kopp (1983) witnessed a relatively high level of throwing behaviour which was not seen in the other two groups. Krakow and Kopp attribute this behaviour to a limitation in the range and repertoire of activities available to the children with Down's Syndrome.

A number of other researchers also report a high rate of repetition in the symbolic play of children with Down's Syndrome (McConkey, 1985; Riguet, Taylor, Benaroya & Klein 1981; Beeghly, Weiss-Perry & Cicchetti, 1990). McConkey (1985) and Riguet et al. (1981) report significantly fewer substitute symbolic acts in children with Down's Syndrome compared to typically developing children matched for developmental age.

Riguet et al. ascribe the lower frequency of play acts to the 'tendency to elaborate the same idea repeatedly throughout a play period' (p.447).

Beeghly, Weiss-Perry and Cicchetti (1990) present data from a study of 35 children with Down's Syndrome in comparison to 41 typically developing children. The authors report that children with Down's Syndrome, with the exception of object substitution, did not differ in terms of the highest level of play, and produced a greater number of play schemes. However, children with Down's Syndrome did not produce a greater number of different schemes but merely repeated existing ones. Furthermore, average play scores for the older cohort of children with Down's Syndrome were lower on all scales of measurement. Taken together the results from these studies suggest a tendency for children with Down's Syndrome to repeat play acts rather than invent novel schemes.

A number of explanations have been advanced for these characteristics of play in children with Down's Syndrome. In the following section anomalies in the pattern of attention, motivation and social engagement are discussed in relation to their potential impact on play. The tendency to view attention as the primary deficit may disguise the causal influences of motivation and social engagement on attention patterns. Therefore, throughout the following discussion, the interrelationship between these factors is emphasised.

6.3.1 Attention in dyadic play

Krakow and Kopp (1983) suggest that the differences in play observed in children with Down's Syndrome may stem from a lack of awareness of the object and social resources available or possibly an inability to make use of such resources. Furthermore, Krakow and Kopp speculate that a lack of awareness may be related to differing patterns of attention in typical play situations. In Krakow and Kopp's study, children with Down's Syndrome directed excessive attention to one stimulus, the toy, in a social-toy situation. Krakow and Kopp suggest this excessive focus on one stimulus reflects an inability to shift attention from the focal object to social engagement.

While Krakow and Kopp's result suggests a preference for the object rather than the social stimulus, a number of studies suggest the reverse preference i.e. excessive attention to social 'objects' (parent, tester, etc.). Both Gunn, Berry and Andrews (1982) and Berger and Cunningham (1981) show that, in a social play situation, children with Down's Syndrome focus more attention towards the caregiver when compared to typically developing children. Kasari, Mundy, Yirmiya, and Sigman (1990) report a similar set of results when children with Down's Syndrome were compared with typically developing children matched for developmental age. Landry and Chapieski (1990) also report a socially biased focus of attention in a joint play situation. A recent study by Ruskin, Kasari, Mundy and Sigman (1994) examined the effects of the relative salience of the social and object stimuli in joint play situations. Ruskin at al. report a similar pattern of environmental monitoring in children with Down's Syndrome as in typically developing children in the object focused situation but a greater social-focus in the social situation.

These results suggest that children with Down's Syndrome may be more socially focused in play than typically developing children matched for developmental age. Furthermore the size of this effect appears to be related to the relative salience of the object relative to the social stimulus (Ruskin et al., 1994; Legerstee & Bowerman, 1989).

Some research suggests that children with Down's Syndrome may have difficulty in redirecting attention, rather than a particular preference for objects or social stimuli. If this was the case the findings of Krakow and Kopp (1983) could be reconciled with studies showing a social preference during play. Evidence suggests that parents of children with Down's Syndrome show more frequent attempts to redirect attention but such attempts may be less effective (Landry & Chapieski, 1989, 1990; Cielinski, Vaughn, Seifer & Contreras, 1995).

Differences in attention patterns found in children with Down's Syndrome could be seen either as causal influences or consequences of an emergent deficit in play quality. Krakow and Kopp (1983) suggest the former explanation, that an excessively focused attentional style is responsible for the repetitive symbolic play observed in children with Down's Syndrome. Krakow and Kopp draw support for this argument from children's performance on other tasks which indicates repetitive behaviour (Berry, Gunn & Andrews, 1984).

However, differences in attention could also be seen as a consequence of different play quality. The socially directed attention bias witnessed in many studies of dyadic play could reflect a relative lack of engagement in object play. An increase in socially directed attention therefore simply reflects a lack of engagement in the alternative activity when children are faced with a choice. However, corresponding preference for social rather than object stimuli may have further effects on the quality of play. In the following two sections the implications of this account are discussed; first in terms of a reduced motivation to engage in object play and second, a correspondingly increased tendency towards social engagement.

6.3.2 Symbolic play and motivation

The central role of motivation as the driving force in play suggests that a motivational account of qualitative difference is particularly plausible (Hrncir, Speller & West, 1985; Yarrow, Morgan, Jennings, Harmon & Gaiter, 1982). Play is characterised as the 'ideal expression of intrinsic motivation' (Goodman, 1996, p.220) and, in contrast to many behaviours, may actually be degraded by external reinforcement (Deci, 1975; Deci & Ryan, 1982; Lepper, 1981). In this section evidence for a motivational deficit in children with Down's Syndrome will be considered. Furthermore, qualitative differences in symbolic play are addressed in terms of a motivational deficit.

A number of studies have suggested that children with Down's Syndrome do not derive as much pleasure from mastery as typically developing children. The use of 'mastery motivation' to describe the motivating force behind children's play has arisen from the notion of competence motivation referred to by White (1959). The drive for mastery in play or exploration of toys is also the driving force in the Piagetian view of assimilation.

Pleasure derived from the application of internal schema to the world is implicit in the constructivist account of development. Mastery may also be an important indicator of concurrent and later developmental status (Messer, McCarthy, McQuiston, MacTurk, Yarrow & Vietze, 1986; Yarrow et al., 1982).

Studies of children with Down's Syndrome suggest a general reduction in mastery motivation in comparison to typically developing children. Gunn, Berry and Andrews (1981) noted that children with Down's Syndrome did not seem to enjoy mastery type activities. Berry, Gunn and Andrews (1984) studied children with Down's Syndrome playing with a 'lock box' (Goodman, 1979) and reported that they appeared not to be interested in mastery of the toy. In contrast, typically developing children were both purposeful and consistent in their exploration of the toy. MacTurk, Hunter, McCarthy, Vietze and McQuiston (1985) have shown that children with Down's Syndrome spend more time looking at and less time engaged in manual exploration of objects.

Consistent with these motivational accounts are studies of children with Down's Syndrome which report lower levels of positive affect associated with task success, or 'causality pleasure'. While children with Down's Syndrome may not react to success with the same speed and intensity of typically developing children (Cicchetti & Beeghly, 1990) it appears that the dampening of affect has a number of task dependent characteristics which explicitly suggest lower motivation. Dunst (1981) has shown in relation to task performance that children with Down's Syndrome show less causality pleasure in completing a difficult task as compared to an easier task. This result is consistent with Rast and Meltzoff's (1995) account of a 'dampening of epistemic curiosity' in children with Down's Syndrome which characterises behaviour in object search. Wishart (1996) reports that children with Down's Syndrome often use 'party tricks' as a means of avoiding difficult tasks.

In children with Down's Syndrome motivational accounts have been cited as a potential cause of differences in play quality and particularly excessive repetition of play schemes. Gunn (1982) suggests that repetition in children's play indicates attainment of a 'comfort level' where children feel secure and competent in their play. Furthermore Gunn suggests that this results in a difficulty in initiating a new focus or direction for further activity. Beeghly, Weiss-Perry and Cicchetti (1990) remark that the observed spontaneous play does not necessarily reflect children's true competencies. Beeghly et al.'s play study found measures of peak symbolic performance did not differ between children with Down's Syndrome and typically developing children. However, within their older cohort of children with Down's Syndrome, deficits in most spontaneous symbolic play measures were found in terms of the mean level of symbolic activity. This discrepancy between peak performance and mean activity in the Down's Syndrome group suggests that a performance or motivational deficit may, in part, explain observed differences in the development of symbolic play.

Some authors cite pre-school intervention programmes as a potential cause of lower motivation of children with Down's Syndrome to engage in spontaneous symbolic play. Gunn and Berry (1989) suggest that intensive intervention may have lowered the mutual enjoyment of play activity for parents and their children. This suggestion is supported by evidence introduced earlier which suggests that directing children's attention often results in a degradation of spontaneous play, particularly in children with Down's Syndrome (Landry & Chapieski, 1989, 1990; Cielinski, Vaughn, Seifer & Contreras, 1995)

The apparent motivational deficit which characterises the lower quality of play in children with Down's Syndrome may also be the cause of differences observed in attention patterns. A relative strength in the capacity of social engagement in children with Down's Syndrome, contrasted with a reduced motivation to engage in symbolic play, may be reflected in a characteristic attention pattern during dyadic play. We now consider the evidence for a relationship between social engagement and symbolic play.

6.3.3 Imitation, social development and symbolic play

Irrespective of motivational weakness which may impinge directly on spontaneous play, children with Down's Syndrome do appear to have a tendency to attend to social objects and this may interfere with play in social situations. Children with Down's Syndrome have been characterised, stereotypically, as being sociable (Gibbs & Thorpe, 1983) and a number of studies have shown evidence for advanced social development relative to more general cognitive skills (Beeghly, Weiss-Perry & Cicchetti, 1990; Krakow & Kopp, 1983; Sigman & Ungerer, 1984). There is also complementary evidence showing an apparent attention bias towards social targets in dyadic play (Landry & Chapieski, 1990)

There is some general evidence to suggest that a relative social strength in Down's Syndrome can interfere with children's performance. Wishart's (1996) work reporting children's misuse of social skills as party tricks is clearly a result of advanced social skills in comparison to developmental age. However, most studies of symbolic play indicate a positive relationship between social functioning, or people orientation and competence in play (Jennings 1975; Fein, 1981).

The relationship between imitation and symbolic play is, at first inspection, a straightforward one. A capacity for imitation enables children to acquire symbolic representations of the social world which are certainly implicated in play (Bandura, 1965). Imitation provides models for symbolic play and is certain to be important in its early development (Charman & Baron-Cohen, 1994; Rogers & Pennington, 1981). Children with Down's Syndrome also appear to respond particularly well to models of play provided by adults (McConkey & Martin, 1984; Shimada, 1988). However, other studies have shown that while modelling does tend to improve children's play, in such cases it becomes neither more elaborate nor more diverse (Jeffree & McConkey, 1976). Furthermore, both Jeffree and McConkey (1976), and Riguet et al. (1981) suggest that although modelling has an immediate effect on the frequency of play acts there is no apparent improvement or carry-over effect in subsequent play. It therefore appears that although imitation does serve a useful function in the play of children with Down's Syndrome, and leads to an improvement under modelling conditions, this improvement is short-lived and limited in quality. In the following section we argue furthermore, that imitation may have a deleterious effect on play quality

In Piagetian terms the relative strength of imitation and accommodation over the assimilation process would have consequences for the quality of play (Piaget, 1951/ 1967). Just as was argued in Chapter 5, the dominance of accommodation results in a failure to generalise or to integrate new knowledge. The accommodation or imitation of new models for play is not therefore reconstructed, or generalised to more abstract objects and contexts. The qualitative distinctions which have been observed in children with Down's Syndrome may therefore reflect an imbalance in the processes underlying play. Play driven by imitation would lack decontextualisation, that is, it would be largely functional and context bound. Children with Down's Syndrome show similar levels of functional play compared to typically developing children matched for developmental age but they show fewer object substitutions (Beeghly, Weiss-Perry & Cicchetti, 1990). Such qualitative differences may suggest a tendency not to produce decontextualised play. Furthermore the failure of children with Down's Syndrome to elaborate play schemes and the tendency to play repetitively could also be seen as a failure to generalise play schemes to other models.

6.4 Summary

In typically developing children, evidence for a broadly Piagetian chronology in the development of early functional and symbolic play is relatively strong. Many studies confirm developmental trends in symbolic play which include increasing decentration, decontextualisationand integration of play acts. The capacity for symbolic play emerges around 18 months and play becomes increasingly sophisticated throughout the first three years. Much of the controversy in studies of symbolic play surround its representational status and links with an understanding of mental states or theory of mind. Leslie (1987) argues for a fundamental isomorphism between children's representations in symbolic play, language and comprehension of mental states, all dependent upon an innately specified capacity for meta-representation. In contrast Perner (1988/1991) argues that while a four year old's understanding of mental states is driven by meta-representation, early pretence is less mature in representational terms.

The impetus for the speculation which surrounds pretend play is largely fuelled by evidence from children with autism who appear to exhibit impairments including a paucity of symbolic play, social interaction and mental state awareness. Studies of children with autism relate the characteristic social impairment, symbolic play impairment and mental state awareness to a common underlying cause in which primacy is attached to one or other of the three domains (Hobson, 1993; Leslie, 1987 ; Perner, 1988/1991)

In contrast to children with autism, children with Down's Syndrome appear to be relatively unimpaired in play, social and TOM domains. Such has been the justification for using children with Down's Syndrome as a comparison group in empirical studies of autistic children. However, it appears that many quantitative measures of symbolic play in children with Down's Syndrome which focus on the highest level of play, proportion of time spent in play and number of play acts, misrepresent the play of children with Down's Syndrome. Evidence has suggested that play in children with Down's Syndrome may be repetitive, rigid and stereotypical (e.g. Krakow & Kopp, 1983). Therefore, while the play 'deficit' in children with Down's Syndrome is certainly distinguishable from the deficit observed in autism, play in children with Down's Syndrome may be far from typical.

Accounts of the differences in play quality which are observed in children with Down's Syndrome suggest differences in both attention and motivation during play. Children with Down's Syndrome appear to remain excessively focused on one stimulus, either object or social during dyadic play. Although some studies show a preference for objects rather than engaging in social interaction most studies show the reverse pattern in which children with Down's Syndrome show an attention bias towards social stimuli. Children with Down's Syndrome appear to respond poorly in comparison to typically developing children when attempts are made to redirect their attention, and mothers of children with Down's Syndrome are reported as adopting different strategies in directing their children's attention.

It is therefore claimed that, far from being a cause of differences in play quality, attentional biases may illustrate a motivationally based failure to engage in symbolic play and a corresponding strength in social engagement. The current chapter has outlined how reduced motivation and social strengths could both serve to weaken underlying representations in play and lead to changes in play quality.

Children with Down's Syndrome are often characterised as showing lower levels of mastery motivation during play. One possible explanation for a difference in play quality is that children with Down's Syndrome are simply less motivated to engage in the type of pretence which appears to be routine in typically developing children. A lack of motivation to adapt and change and elaborate play schemes could therefore be the root cause of a tendency towards repetitive, stereotypical play. Furthermore, Karmiloff-Smith's (1992/1995) model implies that achievement of behavioural mastery is a key step in strengthening and making explicit existing representations. Additionally the reduced motivation to elaborate existing play schemes could reinforce the paucity of the representational basis for play.

It is argued that the social strength in children with Down's Syndrome may be deleterious to play quality. Social skills are certainly important at some level for acquisition of, or accommodation to, models for symbolic play. However the emphasis on accommodation and imitation of new models without the corresponding integration and generalisation processes may result in a lower quality of symbolic play. The discrepancy in domain strengths observed in children with Down's Syndrome, while increasing the number of play schemes, ensures that such schemes remain context bound and stereotypical.

Chapter 12 details an empirical study which investigates the prevalence and relative strength of imitation in the symbolic play of children with Down's Syndrome.

Chapter 7

Methodological Issues

The empirical studies detailed in this thesis are characterised by distinct procedures. However, there are a number of ethical and empirical problems which are common to the studies in general. Work with children and particularly children with Down's Syndrome demands consideration of specific ethical and empirical problems which are described in this chapter.

7.1 Ethical principles for work with infants

The empirical studies in this thesis were carried out with particular reference to the ethical guidelines for conducting research with human participants (British Psychological Society, 1991). The BPS guidelines cover a range of aspects relevant to empirical investigation; consent, deception, debriefing, withdrawal from the investigation, confidentiality, protection of participants, and giving advice. Each of these areas were considered with reference to work with children, and particularly children with Down's Syndrome. Discussion of ethical procedures may encourage increased sensitivity to these issues and increase emphasis in published material (Range & Cotton, 1995). An extended discussion of the ethical procedures adopted during empirical studies is presented in Appendix A.

7.2 Empirical considerations

This section considers the empirical and methodological considerations which apply to studies in this thesis. Work with children, and with atypical populations in general, involves a number of considerations which were addressed throughout the studies.

7.2.1 Participants

The total sample comprised 91 children. Given that a number of children took part in more than one study, details are presented for frequency of participation within each of the empirical groups. Table 7-1 shows the frequency with which children took part in more than one empirical study. Given the limited access which we had to children with Down's Syndrome within an appropriate age range, it was of practical necessity for children to participate in more than one empirical study. At the outset, it was also envisaged that children from the typically developing group would take part in more than one study. However, given the relative speed of developmental progression in this group, and the requirement that the groups be matched in terms of developmental age, many typically developing children were necessarily precluded from participating in more than one experiment.

	1 Study	2 Studies	3 Studies	4 Studies	Total
DS	14	12	8	1	35
NDS	46	10	0	0	56

Table 7-1: Frequency of repeated participation by group

This thesis details five empirical studies. In chronological order of administration these are referred to in this thesis as study one, study two, study four and study five: i.e. study three was carried out after study four. The interval between successive empirical studies is pertinent to the effect of repeated testing on children.

Table 7-2 shows the number of children from each experimental group taking part in consecutive studies, and the mean interval between consecutive studies. Children taking part in more than one, non-consecutive, study are not included in this table. Mean intervals in such cases are in excess of 12 months. Study one is excluded as it was based on questionnaires given to parents and is therefore not relevant to the present discussion.

		DS	NDS
Studies 2 & 4	n =	3	0
	Interval (m)	11.7 (1.5)	NA
	Range (m)	10 - 13	NA
Studies 4 & 3	n =	12	0
	Interval (m)	4.4 (1.2)	NA
	Range (m)	3 - 7	NA
Studies 3 & 5	n =	12	9
	Interval (m)	7.3 (1.0)	7.1 (1.2)
	Range (m)	6 - 9	6 - 9

Table 7-2: Number of children participating in consecutive studies and interval between studies in months (DS and NDS groups)

Repeated testing has a number of possible implications. Children may experience particular learning or fatigue effects which reflect repeated exposure to similar tasks. Furthermore, increased familiarity with the tester may influence performance. Table 7-2 addresses, in particular, the interval between consecutive studies. However, the interval between studies was over three months in the case of every participant and it would seem unlikely that significant carry-over effects could be confounded with empirical effects.

7.2.2 Matching

The issue of matching typically developing children to children from an atypical population is particularly problematic. When using a standard developmental assessment to gauge the developmental age of a child, one needs to be sure that the reliability and validity of its use is established and is comparable in both populations. Wishart & Duffy (1990) identified a number of problems with using developmental scales standardised on typically developing children when assessing the developmental status of children with Down's Syndrome. Children with Down's Syndrome may perform in an anomalous manner during testing which reduces both the reliability and validity of developmental assessments. This issue is pertinent to the correct interpretation of findings and is discussed at length in chapter 8.

Related to this issue is the nature of children's general learning experiences and the various ways in which children with Down's Syndrome systematically differ from typically developing children. Evidently, Down's Syndrome is necessarily associated with what is characterised as a global deficit in learning. The co-occurrence of Down's Syndrome and particular features of learning is often the purpose of empirical investigation. However, Down's Syndrome is also associated with a number of specific extraneous environmental irregularities which prevent the isolation of particular components of Down's Syndrome. Parents of children with Down's Syndrome know before, or shortly after, the birth of their child that he, or she, is likely to have a learning disability and this may effect the nature of their interaction with their children (see, for example, Crawley & Spiker, 1983; Jones, 1977). Furthermore, the involvement of clinical professionals in monitoring and guiding the development of infants with Down's Syndrome is almost universal in the UK. Such intervention necessarily leads to prior experience of clinical intervention and associated developmental assessments. However, the existence of such confounding variables is a characteristic feature of the population and cannot be avoided, particularly if children are to be matched to typically developing children. Given such sources of experimental confounds, it is also important to bear in mind the widely different circumstances experienced by children with Down's Syndrome.

The specificity of claims relating independent to dependent variables is strongly influenced by the adequacy with which matching isolates the independent variable from confounding variables. When studying children with Down's Syndrome, a central issue is the relative specificity with which differences can be ascribed to Down's Syndrome rather than more generally to children with learning disabilities. Throughout this thesis the performance of children with Down's Syndrome is compared to typically developing children. This comparison was considered to be preferable to a comparison with children with learning disabilities (but not Down's Syndrome). We are therefore seeking to identify ways in which children with Down's Syndrome are different from typically developing children. However, we are limited in the extent to which we can claim that effects are specifically due to Down's Syndrome and not to learning disabilities in general.

With respect to this comparison procedure a typical protocol was followed. Attempts were made, where practically possible, to match groups for gender, birth order, and social class. These variables are widely held to affect the development of typically children (Travis & Kohli, 1995). The ratio of male:female participants is detailed in Table 7-3 and includes repeated counts where children took part in more than one study. There is little difference in the proportion of male:female participants between the two empirical groups. Strictly, χ^2 tests are not appropriate when there are repeated counts but for descriptive purposes it is noted that χ^2 (1)=0.12 which would typically be regarded as non-significant.

	Male	Female
DS n=66	33	33
NDS n=66	31	35

Table 7-3: Number of male and female children participating in studies (DS & NDS groups)

Table 7-4 details the birth order of participants in the empirical studies. Once again children taking part in more than one study are counted cumulatively. Although it appears that there are proportionately fewer first born children in the DS group, the difference in the birth order distribution between the two groups was small. In this case χ^2 (2)=1.58 which again would, typically, be regarded as non-significant. The relatively higher proportion of 2nd and 3rd born children in the DS group may reflect the influence of maternal age on incidence of Down's Syndrome.

	1st	2nd	3rd
DS n=66	18	34	14
NDS n=66	24	32	10

Table 7-4: Birth order by group - cumulative frequency for all studies

In order to ascertain the socio-economic status of the two groups we present the social grade classifications of the principal income earners in the families comprising the two groups (Table 7-5). Social grade classifications range from 'A', representing higher managerial, professional or administrative occupations, to 'E', which represent those at the lowest level of subsistence.

	A	B	C1	C2	D	E
DS	0	10	20	26	7	3
NDS	2	12	27	14	7	4

Table 7-5: Frequency of social grouping classifications in sample of participant families

Recruitment of participants was targeted at particular parent-toddler groups so as to optimise the broad range of socio-economic groupings being represented. The groups appear well matched and the frequency of social grade classifications did not differ between the two groups ($\chi^2(5)=6.96$, this would not typically be regarded as significant). The majority of families in both groups fall into the C1 and C2, groupings. However, there does appear to be a slightly higher proportion of C1 families in the NDS group and this may reflect overrepresentation of this group at toddler groups (Finch, 1984).

7.2.3 Testing procedure

Whilst a number of aspects of procedure are discussed in the previous section on ethics, consideration is given here to the specific methodological implications of the procedures adopted in the studies.

In order to reduce the adversity of the experimental situation for the child, and parent, testing took place in children's homes. Testing in the home environment may produce different results to laboratory testing. Durham and Black (1984) found significantly higher levels of performance on developmental assessments carried out in the home in comparison to laboratory-based assessments. Durham and Black identify increased familiarity with the home setting as being responsible for improved performance. Furthermore, children with Down's Syndrome may show an increased incidence of failure to engage relative to typically developing children, and such failure may be more frequent in laboratory settings (Wishart & Duffy, 1990; Hassan & Messer, 1992, & chapter 8). The use of a home setting was therefore considered to increase the naturalistic validity of our experiments and reduce the possibility of specific engagement problems in children with Down's Syndrome.

Prior to each testing session, the purpose of the experiment was explained to parents in general terms, without reference to the expected outcome or empirical hypotheses. All our investigations predicted a within subjects discrepancy in performance between conditions. The parent was thus blind to the nature of the hypothesised prediction and it was considered unlikely that parents would be aware of such predictions. In relation to the performance of their children, parents were asked to be generally supportive and encouraging but not to offer explicit clues or to guide performance. The use of such guidance may otherwise have prompted particular behaviour which was pertinent to the empirical hypothesis.

Given the characteristic psychological and physical features associated with Down's Syndrome and the widespread recognition of these, a double-blind procedure would be particularly difficult to administer. It would also be difficult to disguise the group variable from those rating reliability of judgements. However, inter-rater reliability statistics reported throughout this thesis were based on observations made by a graduate psychologist who was not aware of the empirical predictions of the studies.

During empirical work particular attention was paid to any distress on the part of the child (see Appendix A). However, in infants, distress can occur for a variety of reasons and is often transient. Distress was often identified by parents as being due to the child having particular requirements, such as being hungry or thirsty. After satisfaction of apparent needs children were thus able to resume participation. In cases of mild distress, and with the guidance of parents, attempts were made to re-engage children in the empirical procedure. Where such attempts failed, or distress was judged to be extreme, experiments were curtailed.

Explicit attempts were made to reduce the adversity of the experimental procedure. Prior to each empirical investigation the researcher spent 5-10 mins talking to the parent and attempting to engage with the child using the child's own toys. This was intended to increase the child's willingness to engage in the experimental procedure and engender a sense of fun. Further measures to reduce the child's subjective experience of failure were made by adopting ceiling criteria beyond which further trials were not presented. Therefore, if a child failed a specified number of trials, testing was curtailed. The use of such ceiling criteria compromises the validity of developmental assessment to a certain extent (see chapter 8). However, the alternative to these attempts to increase engagement and reduce procedural adversity increases drop-out rate which is also methodologically dubious. Adoption of ceiling criteria and idiosyncratic attempts to maintain engagement, whilst lacking empirical rigour, represent a compromise to minimise drop-out due to distress. Of 324 testing sessions in total, only four sessions were abandoned due to the child's distress.

7.3 Summary

Ethical and empirical considerations are particularly pertinent in work with children. The studies detailed in this thesis, whilst differing widely in specific procedural techniques, adopted a common approach to recruitment, obtaining consent and debriefing participants. Procedures followed the BPS code of conduct guidelines (1991). Additional attention has been given to recruitment and debriefing of parents of children with Down's Syndrome.

Throughout, distress in children and drop-out rates were reduced to a minimum by adopting more flexible procedures for testing and maintaining engagement, such as the decision to carry out testing in the home and adopt ceiling criteria for performance.

On the specific issue of matching, data on socio-economic status, gender and birth order have been described. Such matching is considered to be important in studies of typically developing children. However, we believe there are issues which apply to children with Down's Syndrome worthy of particular consideration. Children with Down's Syndrome differ from typically developing children in a number of ways which compromise the validity of empirical comparisons with typically developing children. The following chapter will consider this issue in depth.

Chapter 8

Methodological Issues: Empirical Evidence for Stability of Cognitive Test Performance in Infants and Young Children with Down's Syndrome

8.1 Introduction

This chapter addresses specific methodological problems associated with carrying out developmental assessments in children with Down's Syndrome. A number of studies have suggested that such assessments may be unreliable and invalid when applied to children with Down's Syndrome. A detailed experimental investigation of current procedures for determining developmental status addresses the validity and reliability of developmental assessments. The present chapter reports data from an empirical investigation relating to the sequence of development and temporal stability of performance in children with Down's Syndrome. A review of findings from several published studies are also reported.

Research with children with learning disabilities commonly involves comparing these children's performance on particular tasks with that of children with other types of learning disability or younger children without significant disabilities. Such comparisons usually require that children are of a specific developmental level, either generally or with respect to an aspect of development relevant to performance on particular tasks. It is argued that this 'matching procedure' allows researchers to attribute differences in task performance specifically to the disability in question and not simply to generalised differences in cognitive or language development. For example, children with Down's Syndrome are often reported to have 'delayed language' even when matched for cognitive ability with younger non-delayed children (Rondal, 1996; Fowler, Gelman, & Gleitman, 1996). This implies that language is a specific problem for children with Down's Syndrome and cannot be explained by a general 'slowing down' of development.

The procedure by which children are 'matched' is necessarily imperfect and is based on a number of assumptions about the course of children's development. A central assumption is that scales used for developmental assessment track development in the same way for different groups of children and are therefore equally applicable to those with learning disabilities, as to those without. A related assumption is that the developmental profile (i.e. the pattern of test items passed and failed) will be broadly similar given similar overall scores. These assumptions are based on classical developmental theory and what Hodapp and Zigler (1990) terms 'the orderliness, sequentiality, and apparent lawfulness of the transition taking place from [birth] to the attainment of maturity'. Paradoxically, many studies reporting a distinct developmental pathway for children with disabilities implicitly assume a similar course of development when matching.

Research with children with Down's Syndrome has suggested that development may not follow the same sequential pathway in children with Down's Syndrome as that observed in the performance of typically developing children (Wishart & Duffy, 1990). Furthermore, the performance of children with Down's Syndrome may not be as stable over time as that of typically developing children (Wishart & Duffy, 1990; Morss, 1983; Dunst, 1990; Cicchetti and Mans-Wagener, 1987; Karmiloff-Smith, 1992/1995). Such findings, if confirmed, bring into question the results of studies which seek to make comparisons between children with and without Down's Syndrome founded on matched performance on standardised tests. The evidence for performance discrepancies therefore warrants careful scrutiny. The following discussion considers the evidence for such performance discrepancies in terms of the sequence of development, performance instability and failure to engage during testing.

8.1.1 Ordinality

Ordinal scales of development assume that development proceeds in the same way for children with Down's Syndrome as for typically developing children. The validity of this claim is referred to as the 'similar sequence hypothesis' (Hodapp & Zigler, 1990) and was discussed in chapter 2. Many developmental assessments also assume that difficulty increases monotonically for the sequence of test items presented (e.g. Bayley, 1969/1993). This assumption is built into criteria for floor and ceiling effects which dictate where in a particular scale of items, testing will begin and end (Anastasi, 1997). However, what constitutes a difficult task for a typically developing child may not be difficult for a child with Down's Syndrome and vice versa. The possibility that the developmental profile of children with Down's Syndrome may be atypical suggests that there may be a distortion of the relative difficulty associated with particular tasks. It may not be surprising to find that children differ in their developmental profile across domains. For example, some children may be particularly good linguistically and have poor fine motor development. However, whilst developmental scales are designed to accommodate differences between domains the possibility of discrepancies within domains is rarely accounted for.

Wishart and Duffy (1990) suggest that the development of children with Down's Syndrome may follow a different sequential pathway to that of children without Down's Syndrome. 'Normative' studies suggest that tasks comprising the Uzgiris & Hunt Scales form a developmental hierarchy (i.e. the order of difficulty is task 1 - task 2 - task 3 - task 4). This implies that any child passing a difficult task should also perform correctly on easier tasks and that there should be a developmental progression in the ability to pass increasingly difficult tasks. However, Wishart and Duffy report that children with Down's Syndrome may not show the same sequential improvement seen in typically developing children, showing frequent reversals in the order of acquisition. Morss (1983) also reports some idiosyncratic errors in the search performance of children with Down's Syndrome which suggest a different course of development within the object permanence domain.

8.1.2 Instability

An additional methodological problem associated with developmental assessments is the issue of reliability. Morss (1983) suggested that the performance of children with

Down's Syndrome on certain tasks may be unstable. He examined the development of the object concept in a longitudinal study of children with and without Down's Syndrome. Morss compared the performance of eight infants with Down's Syndrome aged from 12 to 22 months with a group of 26 infants without Down's Syndrome aged from 9 months to 21 months. Children performed three tasks designed to assess object concept development. In the Down's Syndrome group, success in the first session was repeated in the following session on only 61% of occasions whilst in the control group successes were subsequently repeated on 77% of occasions. Children with Down's Syndrome were therefore more likely to show regressions in performance across testing sessions. Morss claimed that for children with Down's Syndrome, initial success is less likely to indicate 'secure achievement' than for normal children. However, Morss' results are based on performance across eight sessions for the Down's Syndrome group, but only two sessions for the larger control group. One plausible explanation for the apparently greater performance instability in the Down's Syndrome group is that greater task fatigue in the children with Down's Syndrome resulted in poor engagement.

In a similar study of 85 children with Down's Syndrome on object concept tasks Dunst (1990) argued that performance deterioration may be a feature of the reorganisation required to assimilate environmental events during cognitive stage transitions. Transitions between developmental stages would therefore be characterised by regressions in performance on cognitive tasks, the frequency of such regressions reflecting the relative difficulty of the transition. Furthermore, regressions in performance are more likely to be discernible in a population where stage transitions are made more slowly. However, even when the protracted speed of transitions were accounted for, Dunst reported significantly more regressions in the Down's Syndrome group when compared with normative data reported by Uzgiris (1987). More recent data from Wishart & Duffy (1990) demonstrates that children with Down's Syndrome show fluctuating performance on tests of object concept and standard cognitive tests such as the Bayley scales when given the same test on several occasions. Children with Down's

Syndrome show more frequent regressions in performance when compared to large scale normative studies such as Bayley (1969).

Contrary to the conclusions of the above studies, Hassan and Messer (1992) reported results from a study of six children with Down's Syndrome tested on the object concept and means-ends Uzgiris and Hunt scales at monthly intervals over a period of six months. They report a 'remarkably stable success rate' for both scales. Of the six children tested across the six testing sessions there were no regressions in performance for either of the scales. Furthermore Hassan and Messer found no evidence for a lack of engagement in the tasks.

In order to understand and perhaps ameliorate performance instability, one clearly needs to understand more about the mechanism which underlies such a tendency. Wishart and Duffy (1990) propose that instability may be related to failure to engage in task performance. Evidence for this will now be discussed.

8.1.3 Task avoidance and failure to engage

Children with Down's Syndrome appear to frequently fail test items by default, due to their failure to engage in performing tasks (Wishart & Duffy, 1990). Wishart (1993b) claims that this 'switching out' appears to have a motivational basis. Furthermore, Pitcairn and Wishart (1994) have demonstrated the unique behaviour of children with Down's Syndrome in response to an impossible task, producing 'party tricks' to distract the experimenter or avoiding the testing situation altogether. Such idiosyncratic or avoidant behaviour has also been observed in children with Down's Syndrome performing difficult tasks (those at or above their current level of performance). Wishart and Duffy conclude that this pattern may characterise an approach to learning which is essentially avoidant and results in poor consolidation of newly learned skills. These results suggest that unreliability in performance may not only be a feature specific to children with Down's Syndrome but may correspond to tasks which children find particularly difficult.

It is clearly vital, if matching is to reflect children's cognitive abilities, that the measurements are consistently reliable in both children with Down's Syndrome and the comparison group. The evidence of unreliability and poor engagement and its specificity to the population of children with Down's Syndrome has a number of implications for matching procedures.

8.1.4 Developmental age matching

Wishart and Duffy (1990) claim that to include a control group matched on the basis of mental age (MA) assumes that developmental processes are identical in both groups of children and that this assumption seems unwise. Morss (1985) justifies the lack of extensive MA matching with similar claims, 'the procedure for matching...is extremely problematical' (p. 247). In the absence of a control group, Wishart and Duffy compared the number of regressions observed in the performance of children with Down's Syndrome to the number of items one would expect to be unstable given the Standard Error of Measurement quoted in large scale reliability studies (Bayley, 1969). Similarly, Dunst (1990) compared his data on children with Down's Syndrome with normative data reported by Uzgiris (1987). Evidence suggesting discrepancies both in the reliability and ordinality with which children with Down's Syndrome perform cognitive tasks is counter to many of the assumptions which are implicit in matching.

It must be acknowledged that a tendency for children with Down's Syndrome to consistently under-perform (i.e. failures represent performance as opposed to competence factors) would result in a systematic underestimation of their developmental age. Empirical studies which rely upon matching may be subject to discrepancies in cognitive development which are not apparent in raw scores on developmental scales. Furthermore, a deviation from typical sequential development may cause problems if developmental scales which rely on ordinal difficulty are used as a basis for matching.

However, despite reservations about the adequacy of the current procedures for matching infants for developmental age, the exclusion of control groups from studies of unreliability is unwarranted for a number of reasons. Studies which cite increased failure to engage (Wishart & Duffy, 1990; Rast & Meltzoff, 1995; Wishart, 1991) must account for variation in testing style and other environmental variables which are certain to influence engagement (e.g. Durham & Black, 1978). Furthermore, as an alternative to including a control group, comparisons of instability in children with Down's Syndrome with large scale normative data seem contradictory and provide a 'control' of dubious validity.

It is clear that matching is fundamental to empirical studies based on atypical populations. The objective of the present study was to evaluate the validity of matching children with Down's Syndrome to a group of typically developing children on the basis of developmental age. In order to establish this validity we propose to provide an empirical estimation of scale ordinality, levels of instability and engagement in children with Down's Syndrome under the conditions of our study.

The present study therefore had several aims:

I. to assess the degree to which the scale of difficulty and profile of development observed in typically developing children is observed in the performance of children with Down's Syndrome;

II. to investigate the possibility that children with Down's Syndrome may perform with increased instability when compared to a control group performing the same cognitive tasks;

III. to investigate the relationship between instability, task difficulty and task engagement.

Given the results of these investigations we propose to assess the adequacy of matching children with Down's Syndrome to a control group on the basis of developmental age.

8.2 Method

8.2.1 Participants

12 children with Down's Syndrome (DS) and 12 typically developing children (NDS) from a range of socio-economic backgrounds made up the sample for a short-term study. All infants were capable of retrieving a small occluded object from beneath a cover, i.e. could do at least one task from the Uzgiris and Hunt Scales (Uzgiris & Hunt, 1975). The mean chronological age, age range, birth order, and gender distribution for both groups is shown in Table 8-1.

	CA	Birth Order	Gender
		1st : 2nd : 3rd	female:male
DS (n=12)	31m (18m - 52m)	5 : 5 : 2	7 : 5
NDS (n=12)	19m (14m - 21m)	7 : 3 : 2	7 : 5

Table 8-1: Mean chronological ages of participants, birth order, and gender

Table 8-2 shows the mean developmental ages for both the DS and NDS groups. The Developmental age was calculated as the mean of the two developmental ages assessed with the Bayley at the beginning and end of the study (these assessments were four weeks apart).

	Mean DA (range)
DS (n=12)	18m (12m-29m)
NDS (n=12)	19m (13m-26m)

Table 8-2: Mean developmental ages of participants

8.2.2 Procedure

Each child was seen at home in the company of her parent or close relative on eight occasions. Each child was visited twice a week with at least a day's break between visits.

During the visits, the following three assessments were administered;

1. The Bayley Scales of Infant Development (BSID II)[1] (Bayley, 1969/1993)

This was administered twice, on the first and eighth visit, with an interval of four weeks between assessments. The BSID is a hierarchy of items beginning at one month level and ending at the 42 month level. The starting point for a non-delayed child is dictated by their chronological age but the starting point for children with suspected developmental delay is somewhat arbitrary. Due to the anticipated developmental delay of children with DS and the need to be consistent in administering the assessment, testing began at the 13 month baseline (item 78) for all the children. However, in order to avoid unnecessary distress to the child, testing was terminated if a child failed to pass 10 consecutive items.

2. Object permanence and means-ends scales (Uzgiris and Hunt, 1975)

Object permanence & means-ends scales were administered six times, from second to seventh visit, at twice weekly sessions. The scales were modified versions of the originals (see Appendix B), each scale comprising the six items as used by Gopnik and Meltzoff (1986). On each occasion, children were presented with three items from each scale: the first or last three items from one scale, followed by the last or first three from the other respectively. Three trials were presented at each level of object permanence task. The directions for administering the object concept scale suggest that the items should be administered in order from the 'easiest' to the most difficult item. However, such a procedure potentially confounds the effects of difficulty and task fatigue. Task

[1] This second edition is subsequently referred to as 'the 'Bayley Scales' - explicit reference will be made to the first edition when necessary.

fatigue is especially likely in the case of the object concept scales where all the tasks involve taking an object from the child and hiding it. This is often frustrating for the children and results in a 'failure to engage' and consequent failure. The presentation of object concept items was split between sessions so as to compensate for fatigue effects which might cause children to fail later items on the object concept scale. This procedure minimised fatigue effects which were evident in both groups during pilot testing. Over six visits each full scale was administered three times.

3. Behaviour Rating Scale (BRS) (Bayley, 1969/1993)

This was completed by the experimenter following the object concept and means-ends assessments i.e. on six occasions. The BRS focuses on assessment of three main areas of behaviour for children between 13 and 42 months; an orientation-engagement factor, an emotional-regulation factor, and a total motor quality factor. Inter-rater reliability was assessed for a randomly selected 10% of the sessions and sessions were video taped for this purpose. A second rater, a graduate psychologist, also completed the BRS. The intra-class correlation for overall BRS score was 0.73.

8.3 Results

The results of this study are presented as a description of the ordinality, and stability of developmental scales and as an attempt to address the behavioural factors which influence performance on these scales. Descriptive statistics relating to the developmental scales are first presented. An analysis of the ordinal properties of the developmental scales is subsequently described, followed by data on instability in performance. Finally, the relationship between instability, difficulty and engagement is studied in relation to data from the short-term study. The results of our empirical studies are thus presented in the following order: ordinality of the developmental scales, stability of performance, and behavioural factors related to performance.

8.3.1 Performance on developmental scales

In this section, the scores of each group are presented as raw scores to illustrate a close matching in terms of raw scores. Data is first presented for the Bayley and subsequently for the object permanence and means-ends scales.

8.3.1.1 Bayley Scales

Table 8-3 shows the raw scores on the Bayley (BSID II) for each administration of the test. The optimal score reflects the number of items passed by children irrespective of stability. Thus if a child passed the item at test one, or test two, this would be recorded as a 'pass'.

	DS n=12	NDS n=12
Session 1(s.d.)	108 (18.0)	115 (15.8)
Session 2(s.d.)	112 (20.1)	116 (14.3)
Mean(s.d.)	109 (18.8)	115 (14.8)
Optimal 'summed' (s.d.)	115 (18.3)	120 (13.9)

Table 8-3: Bayley raw scores[2] (s.d.) for DS and NDS groups at test and re-test

Results of a two way (group x session) analysis of variance confirmed no main effect for groups ($F(1, 22)=0.663$ NS) or for session ($F(1,22)= 4.06$ NS). The interaction group x session was also non significant ($F(1,22)=0.394$, NS). These results suggest apparent stability of performance across sessions and close matching in terms of raw test scores.

[2] Item scores were 77 points lower than this. 77 points were credited to each score because testing began started at 13m point in all cases.

8.3.1.2 Uzgiris & Hunt Scales

Table 8-4 and Table 8-5 indicate the mean percentage of children passing items from the object permanence and means-ends scales over 3 sessions. For each session, the criteria for passing an item was correct performance on 2/3 trials. Given that each item was administered on three septet occasions for 12 children in each group, scores reflect the proportion of the 36 item presentations which reached criteria for a pass. The item numbers (e.g. OP4) refer to the tasks as identified by Uzgiris and Hunt (1975); these are described in appendix B.

Task Number (Uzgiris & Hunt, 1975)	OP4	OP8	OP10	OP13	OP14	OP15
Sensorimotor stage	IV	late V	early VI	VI	late VI	late VI
DS	100	94	75	72	72	39
NDS	100	97	97	89	92	53

Table 8-4: Percentage pass rate on OP scale for 3 testing sessions (DS and NDS groups)

Task Number (Uzgiris & Hunt, 1975)	ME4	ME8	ME9	ME10	ME11	ME12
DS	97	97	69	19	22	28
NDS	100	100	86	25	22	36

Table 8-5: Percentage pass rate on ME scale for 3 testing sessions (DS and NDS groups)

8.3.2 The ordinal difficulty of developmental scales

Given the heterogeneity of the items from the Bayley test battery, it is necessary to consider pass rates and measures of reliability for each test item rather than a global measure. Items on the Bayley and Uzgiris and Hunt Scales are intended to form an ordinal scale in which items become increasingly difficult for the child to pass. In the standard administration of the scales, the highest level of performance is represented by the last item passed. The validity of this assumption as applied to children with Down's Syndrome will now be considered.

8.3.2.1 Bayley Scales

Figure 8-1 shows the mean pass rates for individual test items for both DS and NDS groups over two testing sessions. It is clear that some items appear to be more difficult for children with Down's Syndrome when compared to children without Down's Syndrome. This difference is indicated by a lower pass rate for items in the DS sample (i.e.. item 93 -'places circle piece in pink board'). However, there is a great deal of deviation from ordinality in both groups as indicated by the fluctuation in pass rates for adjacent items.

The Rank Correlation between pass rates for the DS and NDS groups was relatively high, r=0.93, indicating a close correspondence in item difficulty for the two groups. However, it would also appear that the pattern of pass rates in the NDS group corresponds more closely to the ordinal scale. The correlation between item number and score was 0.94 for the NDS group and 0.90 for the DS group. Although the correlation is stronger in the NDS group reflecting closer conformity to the ordinal scale, the correlations are not substantially different.

Conformity of individuals to group trends was also examined to establish the variability within each group with respect to the ordinality of the scale. Rank correlation coefficients were calculated for each child in relation to the scores for the overall group. The mean correlation coefficient for the DS group was 0.71(s.d. = 0.13) whilst for the NDS group the mean correlation was 0.77 (s.d. = 0.08). These figures suggest a reasonable level of conformity to the ordinal scale in both DS and NDS groups. A t-test was carried out on transformed correlation coefficients following Fisher (1921). The group difference in correlation coefficients was not significant, $t(22)=1.19$ $p=0.24$.

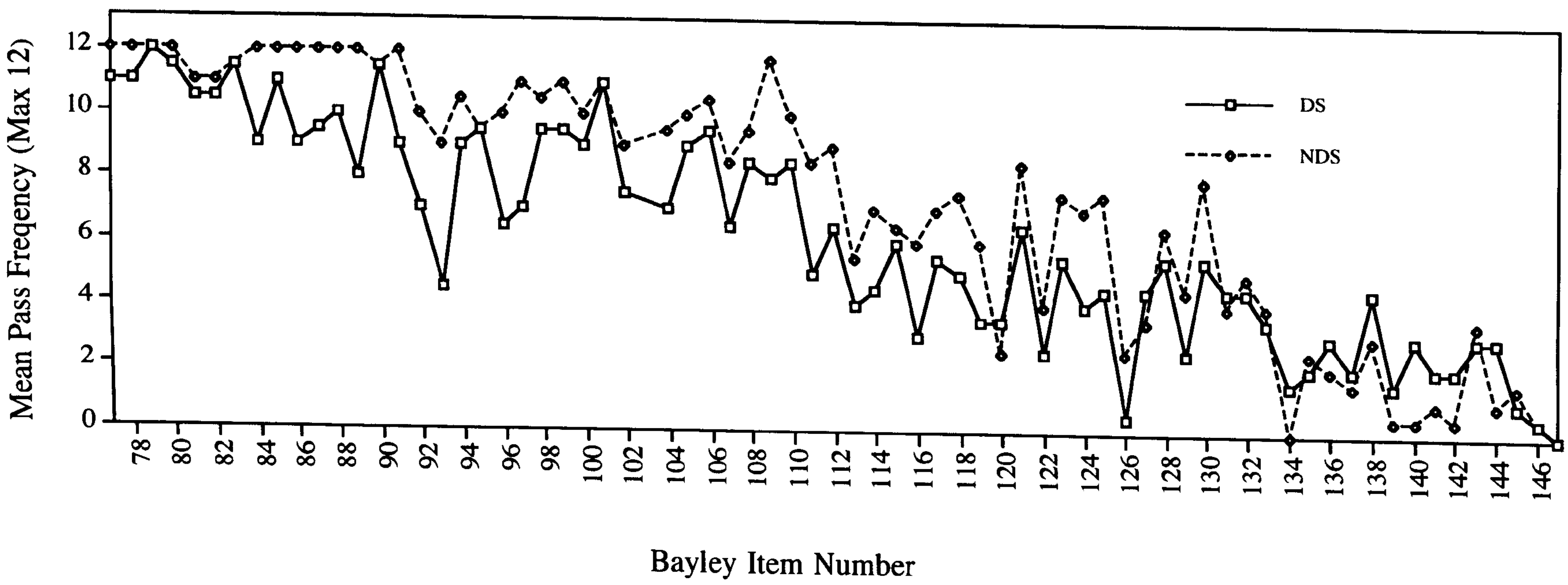


Figure 8-1: Mean pass rates per session by item on Bayley Scales: DS and NDS Groups

8.3.2.2 Uzgiris and Hunt Scales

Overall scores for each group on the object permanence and means-ends scales are shown in Table 8-4 and Table 8-5 respectively. Correspondence between the groups, in terms of ordinal difficulty, was calculated as for items from the Bayley scales. The rank correlation coefficients between item scores for the groups were 0.89 for the object permanence and 0.98 for the means-ends scale. For the object permanence scale, the correlations between item number and item scores were 0.94 for the DS group and 0.93 for the NDS group. This indicates marginally less ordinal conformity in the NDS group. For the means-ends scale, the correlations between item and group scores were 0.79 for the DS group and 0.75 for the NDS group, again indicating marginally less conformity in the NDS group. However, what is most striking about the pattern of results for the means-ends scale is that the concordance in difficulty between the groups is much lower than between each group and the scale order. Taken together, these results imply a global shift in ordinality of the means-ends scale, i.e. children in the DS and NDS groups both show a deviation from ordinality. Referring to Table 8-5 it would appear that item ME 12 is easier than items 10 and 11.

Once again, correlations between each individual and the group scores were calculated to establish the degree of conformity to the group trends. For the means-ends scale, rank correlations were 0.72 (s.d. = 0.25) and 0.68 (s.d. =0.18) for the DS and NDS groups respectively. For the object permanence scale, rank correlations were 0.79 (s.d. =0.26) and 0.82 (s.d. =0.22) for the DS and NDS groups.

T-tests were also carried out on Fisher transformed correlation coefficients between individual item score and group totals. These tests revealed no group differences, either for the means-ends scale $t(22)=0.27$ $p=0.79$, or for the object permanence scale[3] $t(16)=0.51$ $p=0.62$.

[3] Three children from each group performed at ceiling and were therefore excluded from this analysis

It therefore appears that there are anomalies in the ordinality of performance with respect to the developmental scales. However, the generally high correlation between scores in the DS and NDS groups, and the high correlation of individual scores with the group trends, suggests a high degree of consistency between the groups in terms of ordinal difficulty.

8.3.3 Instability in performance on test items

In this section we consider the stability of performance across sessions on individual test items which constitute the Bayley and Uzgiris and Hunt scales. If a child is given the same test item on two occasion the performance pattern may suggest either stability or instability. Stability entails a consistent pass or failure on both testing occasions. Instability can also be manifest in one of two ways. An 'improvement' represents an item passed on the second session which was failed on the first session. A 'deterioration' represents an item failed at the second session which was previously passed. Our subsequent analyses will take account of the relative frequency of such patterns of performance. Whilst improvements represent performance instability they may also represent genuine development and learning. In contrast, excluding the possibility of mental deterioration, regressions imply that a child fails to perform despite recently having the appropriate skills within her repertoire.

8.3.3.1 Bayley Scales

Raw, 'whole test', scores such as the above may disguise underlying instability by failing to consider the profile of performance across items from the assessment battery. For example, it was possible for a child to achieve the same raw score on the second testing as on the first session despite failing many of the items passed on the first occasion by passing items previously failed. In order to determine whether children may be unstable in the pattern of items passed and failed, the frequency with which regressions and improvements occurred between the successive administrations of the Bayley was examined.

Table 8-6 shows the frequency of improvements and regressions for the DS and NDS Groups. Data from Wishart and Duffy (1990) have been included for comparison.

	n	No. of items presented	Regressions	Improvements	Stable Items
DS (Present Sample)	12	58	4.5 (12)	6.5 (9)	47.0
NDS (Present Sample)	12	55	3.6 (7)	7.1 (9)	44.3
Wishart & Duffy (1990)	18	37	5.4	4.4	27.2

Table 8-6: Mean no. of regressions, improvements and stable items per child on Bayley Scales II (range in brackets)

The data from Table 8-6 are presented in Table 8-7 as percentages of total number of administered test items.

	N_p (children)	N_i (mean items)	Regressions %	Improvements %	Stability %
NDS Horner (1980) (age range 9m - 15m)	48	43	7	9	84.6
DS Wishart & Duffy (1990[4]) (age range 6m - 48m)	18	37	11	14	75.1
DS (Present Sample) (age range 18m - 52m)	12	58	8	11	79.2
NDS (Present Sample) (age range 14m - 21m)	12	55	7	13	80.6

Table 8-7: Percentage of item deterioration, improvement, and agreement in test - retest performance

Table 8-7 shows the proportion of items from the second testing session which represent regressions, improvements and stability when compared to performance on items during the first testing session. This table also presents, for comparison, data from a large scale normative study, Horner (1980). However, data taken from different studies must be interpreted with caution particularly where testing was undertaken with children of different ages. Percentage agreement represents the combined proportion of items consistently passed or failed in both testing sessions. All the studies report a 75%-85% consistency in children's performance on test items, irrespective of whether or not children had DS. A two-way analysis of variance (regressions & improvements x group)

[4] figures from Duffy (1990) p. 82

revealed no group difference in the frequency of regressions or improvements ($F_{(1,22)}=0.00$, NS). However, there do appear to be more improvements than regressions ($F_{(1,22)}=7.84$, $p=0.01$) as confirmed by a t-test between the regression and improvement frequencies across both groups ($t(23) = 2$, $p<0.01$). The interaction of regression and improvement frequency x group was not significant ($F(1,22)=0.22$, NS). Thus the relative frequency of regressions and improvements does not appear to be group dependent.

It would appear in the short term, repeated testing gives rise to a greater proportion of improvements that regressions on test items. However, there does not appear to be any definitive evidence that children with Down's Syndrome show a relatively higher proportion of regressions than that in typically developing children.

Thus with respect to the frequency of regressions, which was the focus of this investigation, it does appear that children in the DS group show more regressions than the NDS group. Given the large standard deviations and test-retest interval these results must be interpreted with great caution and statistical tests were not carried out.

However, despite apparently comparable levels of stability, it may be that the items for which children with Down's Syndrome show poor stability are different from the items in the NDS group. Given small sample sizes in our study, and the relatively high consistency in overall performance, these data are unlikely to be robust and are not presented here. However, items showing particularly poor short-term reliability for the DS and NDS groups are shown in appendix C alongside a similar list of items reported by Duffy (1990).

8.3.3.2 Uzgiris & Hunt Scales

This section presents an analysis of instability in performance on object permanence and means-ends scales. Given that there were three administrations at weekly intervals of each item from these scales, the patterns of instability are more complex. However, as was the case for instability in item performance on the Bayley scales, a regression represents a failure on an item which was previously passed.

Table 8-8 shows the mean number of regressions for the Uzgiris and Hunt scales. There were no significant group differences in the frequency of regressions for either the object permanence scale, $F(1,22)=0.186$ NS, or for the means-ends scale $F(1,22)=0.178$ NS.

	Object - Permanence Scales	Means-Ends Scales
DS (N=12)	0.67 (0.78)	0.42 (0.51)
NDS (N=12)	0.75 (0.87)	0.42 (0.67)

Table 8-8: Mean frequency (per child) of test-retest regressions in performance(s.d.)

Table 8-9 illustrates the percentage of improvements and regressions between successive administrations of the object permanence scales. The relevant data from Wishart and Duffy are also included. The proportion of regressions do not differ substantially between either the NDS and DS groups including Wishart and Duffy's sample. What is striking about these data is the high level of stability in all three samples.

	N_p (Children)	N_i (Mean Items)	Regressions %	Improvements %	Stability %
Wishart & Duffy, 1990 (DS) (mean age 21m)	18	4	5.5	11.0	83.5
Uzgiris & Hunt, 1975 (NDS) (mean age 10m)	84	10	-	-	79.0
DS (mean age 31m)	12	6 (x2)=12[5]	3.7	4.6	91.7
NDS (mean age 19m)	12	6 (x2)=12	4.4	4.6	91.0

Table 8-9: Mean proportion of improvements and regressions in performance on object permanence scales as a percentage of total tasks administered.

[5] data from three sessions are presented as the cumulative total of regressions accumulated during the second and third testing sessions.

Table 8-10 illustrates the percentage of improvements and regressions between successive administrations of the means-ends scales. Data from Uzgiris and Hunt (1975) are also included for comparison. The proportion of regressions do not differ between the NDS and DS groups and, as with the object permanence scales, a high level of stability is apparent in both groups.

	N_p (Children)	N_i (Mean Items)	Regressions %	Improvements %	Stability %
Uzgiris & Hunt, 1975 (NDS) (mean age 10m)	84	13	-	-	75.5
DS (mean age 31m)	12	6(*2)=12[6]	2.3	6.9	90.8
NDS (mean age 19m)	12	6(*2)=12	2.3	4.1	93.6

Table 8-10: Mean proportion of improvements and regressions in performance on means-ends scales as a percentage of total tasks administered.

8.3.3.3 The relationship between instability and difficulty

It seems reasonable when considering inconsistency in performance to consider the relative difficulty of items as performed by both groups. Items on which children perform inconsistently may be distributed differently for the DS and NDS groups. The consistency of performance was examined according to relative difficulty of test items within each group. Bayley items were divided into four difficulty quartiles according to

[6] In the case of the present study of performance over three testing sessions, patterns of instability were more complex. However, as with the other studies, a regression indicates an item which was failed despite being passed at the session immediately preceding it. Data from three sessions are presented as the cumulative total of regressions accumulated during the second and third testing sessions.

the pass rates on items for each group. The first quartile therefore represents the easiest 25% of test items according to performance within each group i.e. this will be a different item set for each group.

Figure 8-2 shows the number of regressions in test-retest performance on items according to relative difficulty within each group.

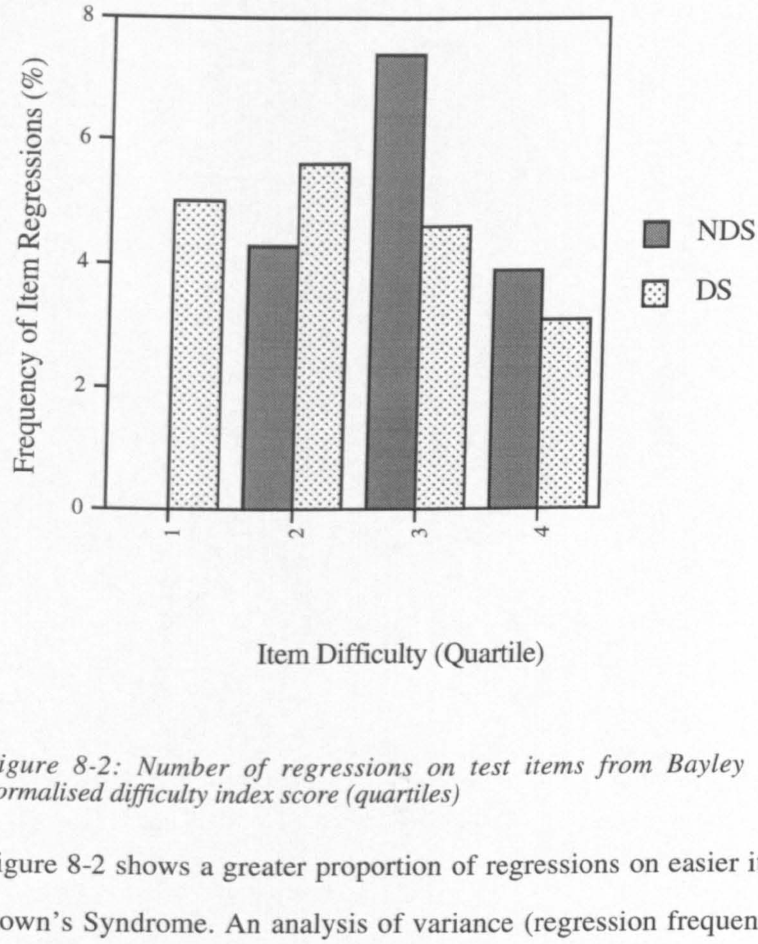


Figure 8-2: Number of regressions on test items from Bayley by normalised difficulty index score (quartiles)

Figure 8-2 shows a greater proportion of regressions on easier items for children with Down's Syndrome. An analysis of variance (regression frequency x group x quartile) was carried out to determine if the pattern of regressions was different for the two groups. The main effect of quartile was significant ($F(3,132)=2.91$, $p<0.01$) as was the interaction group x quartile ($F(3,132)=5.86$, $p<0.01$). T-tests revealed a significant difference for the first quartile only i.e. the easiest items, ($t(28)=4.17$, $p<0.001$). These results therefore reflect a tendency for children with Down's Syndrome to show regressions on the easiest items in contrast to typically developing children. The correlation between difficulty and frequency of regressions was significant for the NDS group, $r=0.25$ $p<0.05$, but not for the DS group, $r= -0.22$, NS. The negative correlation in the DS group indicates a reduction in regression frequency with increasing difficulty, whilst the reverse pattern is observed in the NDS group.

8.3.4 Behaviour Rating Scale

A number of studies have suggested that the instability in children with Down's Syndrome may have a behavioural cause. Data from the behaviour rating scales (BRS) is presented here to address this possibility. The mean group scores by testing session for the BRS are shown in Table 8-11.

Session	1	2	3	4	5	6	Mean
Emotional Regulation Score							
DS (N=12)	38.6	39.1	38.9	37.0	37.6	37.6	38.1
	(3.9)	(6.6)	(5.0)	(4.6)	(5.6)	(5.1)	(4.9)
NDS (N=12)	41.7	41.4	40.6	41.9	39.5	41.3	41.1
	(5.2)	(5.7)	(5.2)	(3.3)	(5.2)	(5.2)	(4.9)
Orientation / Engagement Score							
DS (N=12)	30.3 *	31.1*	30.6*	29.8*	30.4*	30.9*	30.5*
	(3.2)	(2.7)	(2.7)	(3.0)	(2.0)	(2.9)	(2.7)
NDS (N=12)	33.6	31.6	32.2	32.6	32.6	32.0	32.5
	(4.8)	(4.6)	(3.6)	(3.3)	(3.8)	(3.5)	(3.9)
Total Scores							
DS	115.3	110.8	117.1	111.8	115.3	112.8	113.7
	(8.4)	(11.0)	(6.6)	(5.7)	(6.7)	(7.5)	(9.1)
NDS	110.1	119.3	110.9	114.4	112.6	111.1	115.2
	(13.0)	(9.4)	(13.1)	(11.6)	(8.4)	(12.4)	(11.7)

*Table 8-11: BRS scores (and s.d.) by session for emotional regulation and orientation/engagement (DS and NDS groups) * Indicates 'questionable' behaviour*

The scores are broken down into two factors; an *orientation-engagement* factor, and an *emotional-regulation* factor. The orientation-engagement factor measures a child's tendency to approach or avoid interactions which are task-related or social. The emotional regulation factor measures the child's 'activity, adaptability, affect, co-operation, persistence, and frustration tolerance'. Low scores on any scale indicate questionable behaviour (i.e. in the lowest 11-25th percentile) and non-optimal behaviour (0-10th percentile) in the extreme cases (Bayley, 1993).

According to normative data provided by Bayley, orientation scores for the Down's Syndrome group may be regarded as 'questionable'. A low score on this factor indicates a 'low level of initiative and involvement with tasks, and a reluctance to engage socially' (Bayley, 1969/1993, p.231). Two-way (group x session) analyses of variance were carried out on each of the two subscales, and the overall BRS scores. Orientation / Engagement scores for the DS group were significantly lower than those of the typically developing children. $F(1, 120)=7.08$ $p<0.05$. Group differences were not significant either for the emotional regulation scores or for the overall rating scores. $F(1, 120)=2.97$ $p=0.146$ for emotional regulation, and $F(1, 120) = 0.04$, $p=0.850$ for total behaviour rating score by group.

8.3.4.1 The relationship between behaviour and stability

In order to investigate the relationship between instability on cognitive measures and behaviour ratings, correlation coefficients were calculated for each group. The correlation coefficients between measure of cognitive instability and behaviour ratings are shown in Table 8-12 and Table 8-13. Given that positive behaviour is credited with a high behaviour rating, one might expect instability and regressions in particular to be negatively correlated with these ratings. However, most correlation coefficients are small, many are positive, and none of the coefficients reached significance.

Scale	Orientation/ Engagement	Emotional Engagement	Total Behaviour Score
Bayley Scale	0.05	-0.29	-0.03
Object Permanence	-0.39	-0.15	-0.34
Means-Ends	0.29	0.27	-0.14

Table 8-12: Correlation coefficients for regressions in cognitive performance and behavioural rating: DS Group

	Orientation/ Engagement	Emotional Engagement	Total Behaviour Score
Bayley Regressions	0.16	-0.11	-0.07
OP Regressions	0.24	-0.01	-0.01
Me Regressions	0.29	0.37	0.31

Table 8-13: Correlation coefficients for regressions in cognitive performance and behavioural Rating: NDS Group

8.4 Discussion

This methodological investigation had three aims, first to establish the degree to which children with Down's Syndrome follow a typical ordinal sequence with respect to task performance. Second, to investigate the possibility that children with Down's Syndrome may perform with increased instability and finally, to examine the possibility that instability might be related to task difficulty and to behaviour during testing. These three aims and the consequent validity of matching groups on the basis of developmental assessments will now be discussed in the light of the evidence presented.

8.4.1 Ordinality of the developmental scales:

Use of the BSID II and the Uzgiris and Hunt Scales in assessment of cognitive development in children with Down's Syndrome implicitly assumes that these scales track development in the same way as for typically developing children. Items are intended to form an ordinal scale of difficulty and items are therefore presented to children in order of difficulty. The routine adoption of floor and ceiling criteria during testing also implies that children's performance will adhere to the ordinal profile of the scales.

The data suggest a similar degree of conformity to the ordinal difficulty scale both in children with Down's Syndrome and in the typically developing group. Furthermore, children within each group show a close correspondence to the group profiles in terms of item pass rates. There is thus no evidence for increased variability between children in the Down's Syndrome group with respect to variability within the typically developing group. However, both groups do appear to deviate from the ordinal pattern which is implicit in the scales. Global differences such as this could be due to adoption of particularly conservative or liberal criteria for items by the examiner or due to normal individual variation in children's strengths and weaknesses. In particular, deviation from ordinality is most striking in terms of performance on the means-ends scale. It is perhaps not surprising that performance on such a heterogeneous scale should deviate from ordinality with a sample of this size.

In summary, children with Down's Syndrome show a performance profile on the developmental scales administered which conforms to the pattern observed in typically developing children. Despite some anomalies in terms of item difficulty within each of the developmental scales it would be premature to conclude that the use of such scales is invalid. The small sample size used in this investigation means that such discrepancies are unlikely to be robust.

8.4.2 Stability of test-retest performance on developmental scales

The second aim of our investigation was to determine the test retest stability of performance on items which comprise each scale. There is increasing evidence to suggest that the performance of children with Down's Syndrome may not be as stable as that observed in typically developing children. Such findings threaten the reliability of such scales and consequently the validity of studies using groups matched on the basis of performance.

Whenever a child is given the same task on two different occasions, instability can be manifest in one of several different ways. One possibility is that the child fails the task on the first occasion and passes it on the second. Such a pattern reflects performance instability, but could also reflect a genuine development in the child's competence. However, how can we account for a pass on the first occasion followed by a failure on the second? In this case we can be sure that the item was within the child's repertoire (assuming that we can reject the possibility that the child passed by chance) and attribute the second failure to a regression in performance on that task.

Referring to the aims of our study, we found firstly that the quantitative measures of instability suggested by Wishart and Duffy (1990) appear to indicate no more performance instability, and particularly performance regressions, in children with Down's syndrome than typically developing children. Reliability over short term test-retest intervals shows consistent performance on over 80% of Bayley test items in both groups. The data presented on short term test stability in Down's Syndrome suggests similar rates of instability to the present control group and to other large scale normative studies (Bayley, 1969; Horner, 1980).

It is clear that levels of stability between studies do appear to vary from 75% to 85% within the typically developing populations. Although comparisons between studies must be drawn with caution, this between-study variation would seem to more than adequately encompass results from Wishart and Duffy's study of children with Down's Syndrome. Furthermore, the absence of a control group in the latter study means that situational variables might have encouraged elevated instability. Performance consistency for object permanence and mean-ends scales in the current study also show similar levels of stability in the DS and NDS groups.

Reports of greater instability in children with Down's Syndrome are not universal. Hassan and Messer (1992) report high levels of performance stability in testing which took place at children's homes. This finding, and the current results, suggest that if there are increased levels of instability in children with Down's Syndrome then instability may be limited to more formal testing situations. This finding together with the results presented here may therefore provide justification for a less formal, and more flexible, testing procedure particularly with children with Down's Syndrome.

8.4.3 The effects of item difficulty on performance stability

It has been suggested that performance instability in children with Down's syndrome may be related to task difficulty. Wishart and Duffy reported that instability was more frequent with items which were relatively difficult. The distribution of unstable items was considered with respect to item difficulty within each group. The pattern of regressions appears to be more heavily loaded on easy items for the DS group (Table 8-7). This pattern is not consistent with the findings of Wishart and Duffy who found a greater proportion of item regressions above the midpoint. However, the current data reveal a clear tendency for regressions in children with Down's Syndrome to occur on the easiest items rather that the most difficult ones.

Children with Down's syndrome may not perform optimally for reasons similar to those known to influence performance in typically developing children. However, whilst a uniform increase in instability in children with Down's Syndrome could be explained by an exaggeration of the typical motivational factors such as a poor attentional capacity (Krakow and Kopp, 1983), the pattern of instability observed in our sample of children with Down's Syndrome suggests otherwise. The differential instability of easier test items suggests that the performance of children with Down's Syndrome is mediated by motivational factors which differ in quality from typical patterns of motivational variation.

8.4.4 The relationship between behaviour during testing and performance stability

The third and final aim of the present investigation was to evaluate the extent to which behavioural factors may be responsible for increased levels of instability.

When examining behaviour during testing, it is important to recognise that children with Down's syndrome, like all children with 'developmental delays', are generally older than children in developmentally matched control groups. Such a discrepancy in chronological age may result in performance anomalies which relate to the deployment of advanced social skills and a consequent 'failure to engage' (Wishart and Duffy , 1990). Wishart (1996) refers to the increased use of party tricks by children with Down's Syndrome, a strategy which may not be available to younger, typically developing children. In addition, as Duffy (1990) mentions, children could plausibly 'outgrow' an item which is part of an assessment. Easier items are therefore less cognitively relevant to older children and this may explain a higher incidence of instability as a result of lower levels of implicit 'cognitive' motivation (White, 1969; Harter, 1974). A combination of advanced social skills and lower levels of motivation may also result in avoidance of a wide range of tasks which are nonetheless within children's cognitive capabilities.

The results presented in this chapter support the view that the task orientation and engagement of children with Down's Syndrome may be different to that of typically developing children. The behaviour of children with Down's Syndrome was rated as 'questionable' in respect of orientation and engagement suggesting a reduced willingness to co-operate in the assessment regime. However, correlations between behavioural measures and levels of instability suggest that there is not a direct relationship between these effects.

Despite the lack of strong evidence for a relationship between performance instability and behaviour during testing, the reduced levels of orientation and engagement witnessed in children with Down's Syndrome is consistent with findings from a number of studies. Wishart (1993) found that children with Down's syndrome appear reluctant to approach tasks just above their current developmental level and also react idiosyncratically when faced with an impossible task (Pitcairn and Wishart, 1994). Wishart and Duffy (1990) and Morss (1983) also noted that children with Down's syndrome often make atypical 'errors' when performing object permanence tasks. Rast and Meltzoff (1995) characterise these motivational differences in children with Down's Syndrome as a 'dampening of epistemic curiosity' which reflect an unwillingness to engage in task performance.

In summary, the findings in relation to the aims of this chapter suggest that whilst instability may not be increased in children with Down's Syndrome, there are a number of reasons to believe that the performance of these children may be atypical. Children with Down's Syndrome showed increased unreliability on relatively easy items and showed lower levels of task engagement during testing. Taken together, these findings are strongly supportive of motivational accounts of instability. Furthermore, these findings suggest that assessments may underestimate the cognitive abilities of children with Down's Syndrome.

8.4.5 Developmental assessment of children with Down's Syndrome

Whilst it is not surprising that the relative difficulty of items for children with Down's Syndrome is not equivalent to that for typically developing children it is worrying that measurement error appears to be more heavily loaded on easy items for children with Down's Syndrome. The consequences of unreliability of this kind are twofold. Firstly, such systematic differences in reliability patterns may adversely affect the reliability of developmental age assessments based on floor and ceiling criteria. For example, on the basis of a string of failures on easy test items, the testing of a child with Down's Syndrome could be prematurely curtailed despite the child's capability of passing a number of more difficult items which are not presented. Such a procedure would result in a systematic underestimation of developmental age with consequences for the progress of early intervention, psychological research and decisions about schooling which may be based on such assessments. Secondly, if the difference in reliability patterns reflects, as has been suggested, a failure to consolidate skills, it may present more immediate developmental problems for the child with Down's Syndrome. Such a position has been adopted by Wishart (1995).

Furthermore, the lower task engagement found in children with Down's Syndrome, whilst not directly responsible for instability may result in a global underperformance on cognitive assessments. Rauh (1997) reports that behavioural measures may predict subsequent test performance in children with Down's Syndrome as well as an initial cognitive measure. Thus, as a result of both motivational and purely cognitive anomalies, the standard administration of cognitive assessments may provide an inadequate assessment of developmental age for children with Down's Syndrome. For example, the manual for administration of the BSID II recommends that, for children with known developmental delays, testing should begin at an 'educated guess' of the child's developmental level. This starting point would seem rather arbitrary and could lead to radical differences in performance depending upon the starting point. Children with Down's Syndrome on the basis of atypical developmental profiles and anomalous motivation may fail items earlier in the scale. Failure on an item, or series of items, could result in premature curtailment of testing and give an inaccurate estimate of developmental age.

In the light of evidence for comparable levels of stability in children with Down's Syndrome and typically developing children it would seem premature to abandon matching groups on the basis of developmental age. However, the possibility of an atypical profile in instability suggest that establishing an appropriate starting point for assessment may be crucial to the validity of the measure. One solution would be to establish a pre-test battery to give a rough estimate of children developmental age in order to proceed with testing at a more objective baseline. However in the absence of such a battery, a number of cautionary procedures will be adopted in carrying out developmental age assessments to ensure the adequate matching between children with Down's Syndrome and typically developing children. To circumvent problems of children reaching a premature ceiling, all children will be tested over a complete set of items and testing will only be curtailed following a complete and protracted sequence of failures. Whilst one cannot abandon absolutely the ceiling criteria, for practical and ethical reasons, it would seem worthwhile to continue testing for up to ten items before terminating a test session. Testing will only be terminated if a child fails ten consecutive items or appears unduly distressed.

The results presented in this chapter suggest that levels of instability in children with Down's Syndrome are broadly similar to those observed in typically developing children. However, the distribution of instability appears to be skewed towards developmentally easier items in contrast to typically developing children. This finding suggests that easy items may be 'difficult' for children with Down's Syndrome. Tests administered according to floor and ceiling criteria may therefore not be valid or reliable assessments of cognitive competence. The finding that children with Down's Syndrome show lower levels of task orientation and engagement suggest that failures may not reflect children's true competencies. Attention must therefore be paid to factors which influence the motivation and engagement of children with Down's Syndrome particularly variables related to the testing environment.

In the subsequent chapters the development of representation within a number of domains is considered in relation to children with Down's Syndrome. These experiments are based on the assumption that developmental assessments provide a valid and reliable measure of children's developmental status. The results presented in the current chapter and the procedures adopted as a consequence will serve to limit any unreliability in the developmental assessment of children with Down's Syndrome.

The following chapter considers the extent to which cognitive development in children with Down's Syndrome may be linked to and limited by motor development.

Chapter 9

Study 1: Object Permanence and Motor Development

9.1 Introduction

This chapter describes a study to investigate the links between motor and cognitive development in children with Down's Syndrome. Hypotonia, or floppiness, is often associated with babies and infants who have Down's Syndrome and major motor milestones are often delayed in comparison to typically developing children. There is some empirical evidence to suggest that motor development may have an impact on cognitive development (Bertenthal, Campos, & Kermoian, 1994; Kermoian & Campos, 1988). There are also theoretical reasons to believe that object permanence should be linked to children's experience of self generated locomotor activity (Piaget, 1955/1976). In this chapter the evidence for specific links between locomotor experience and object permanence performance is introduced in relation to typically developing children and children with Down's Syndrome. The results of an empirical investigation are subsequently presented and discussed.

9.1.1 Cognitive and motor development in typically developing children

Piaget ascribed a great deal of significance to the child's early motor development as a prerequisite to thought (Piaget, 1955/1976, 1953/1970). Early sensorimotor experience was seen by Piaget as a precursor to mental representation and necessitates an increasingly sophisticated mastery of fine and gross motor skills over the first 18 months of life. A number of empirical studies carried out on typically developing children support the view of a link between cognitive and motor development during infancy. Trevarthen (1968) argues that early postural control may be important for the child to establish a frame of reference for directing attention. Postural control allows the body to serve as a frame of reference for fine motor skills such as reaching and tool use. Children's awareness of depth as indicated by wariness also appears to correspond to motor development and the onset of crawling in particular (Bertenthal & Campos, 1984). Further changes in social and exploratory behaviour also appear to coincide with the ability to locomote. Children show a greater interest in social stimuli when either able to crawl or use a baby-walker (Gustafson, 1984). The onset of crawling is evidently an important transition for children's cognitive development and facilitates greater social awareness. More specifically however, children's motor development may have particular implications for children's performance on object search tasks.

There is growing evidence to suggest that children's early search capabilities may not reflect a lack cognitive or representational capability but motor limitations (Bower and Wishart, 1973; Diamond, 1991). Bower and Wishart (1973) have shown that failure to search may, at least in part, be attributed to lack of motor skill. Evidence for this focuses on children's visual tracking of hidden objects before they are able to search for them. Children clearly appear to have the necessary representations of hidden objects well before they begin to search (Baillargeon, Grabber, DeVos, & Black, 1990). Such awareness of objects suggests that failure to search must implicate either motor limitations or inability to plan and execute manual retrieval (Diamond, 1991).

Once children begin to execute successful search at a single location, they must develop sufficient spatial awareness to tackle a two location task. The link between locomotor experience and awareness of the properties of the spatial environment was first postulated by Piaget (1955/1976). Piaget suggested that success on the two location search task required spatial awareness beyond the capabilities of the average 9 month old. Many researchers emphasise the theoretical significance of locomotor experience in determining children's knowledge of the spatial environment (Piaget, 1955/1976; Russell, 1996; Bertenthal, Campos, & Kermoian, 1994; Kermoian & Campos, 1988).

Empirical evidence to support specific links between locomotor experience and spatial representation is provided by a number of researchers (Bremner & Bryant, 1977;

Bremner, 1988; Acredolo, 1978; Acredolo, Adams, & Goodwyn, 1984). Bremner and Bryant (1977) and Bremner (1985) examined the performance of infants on a two location search task under two conditions. In the first condition, infants were moved relative to the locations between successive hidings. In the second condition, the locations themselves were transposed. The results suggest that infants performed better when they themselves were moved relative to the hiding locations. Acredolo, Adams and Goodwyn (1984) have shown that infants were more successful on a two location search task if they crawled around a barrier than if they were carried around it. Taken together, these empirical results suggest that an infant's spatial reference may be linked to their experience of movement and self-generated movement in particular. Acredolo (1978) suggests a direct link between an infant's ability to crawl and the acquisition of an allocentric (or world-centred) spatial representation. Prior to this change, children's spatial awareness is characterised by an egocentric spatial code which is responsible for search errors such as the A-not-B error (Horrobin & Acredolo, 1986). The experience of self-generated locomotion through crawling may therefore contribute to an increased experience of agency (Russell, 1996), a corresponding decline in egocentricity, and success on search tasks.

Kermoian and Campos (1988) examined the relationship between experience of locomotion and performance on object permanence tasks in typically developing children. Three groups of children matched for developmental age had different levels of locomotor experience. A group of children who had just begun to crawl were compared to two groups of pre-locomotor infants. One of the pre-locomotor groups were given baby walkers to facilitate the experience of self-generated locomotion. This 'walker-assisted' group were allowed two hours experience per day over a period of seven weeks. The findings suggested that performance on object permanence tasks was facilitated by locomotor experience whether through crawling or walker-assisted. Kermoian and Campos suggest that locomotor development may facilitate, though may not necessarily induce, developmental changes.

It is perhaps not surprising that typically developing children show some association between developmental milestones in both motor and cognitive performance. The domains may be linked by common maturational processes such as development of the prefrontal cortex (Diamond, 1991). Thus in typically developing children it may be inherently difficult to elucidate the direction of cause and effect in linking motor and cognitive performance. However, stronger evidence to suggest a causal relationship between locomotor and cognitive development may be gleaned from populations that experience a specific motor impairment relative to other domains. The case of a child, 'Jup', described by Gouin-Décarie (1969), whose ability to crawl was severely limited, illustrates that restriction of locomotor experience had only a marginal effect on her intellectual development. This case, in contrast to studies of typically developing children suggest the absence of a link between locomotor experience and object permanence performance. Despite the fact that in this case, the child was able to locomote in a limited manner, one would expect a more profound delay in object permanence if there was a strong link between these domains. However, Kermoian and Campos (1988) argue that locomotor experience may facilitate object permanence development rather than being a necessary causal influence. A larger sample of children with motor delays is clearly required if such a hypothesis is to be fully investigated.

9.1.2 Cognitive and motor development in children with Down's Syndrome

A number of studies have shown that, while the early gross motor milestones such as rolling or sitting are only slightly delayed in children with Down's Syndrome, later milestones such as standing and walking are more profoundly delayed (Carr, 1988). Henderson (1985) reports that although typically developing children sit independently at seven month, stand unsupported at 11 months, and walk at 12 months, children with Down's Syndrome usually achieve such milestones at 9, 18, 19 months respectively. There also appears to be much greater variability in milestones within the Down's Syndrome population compared to typically developing children. Children with Down's

Syndrome begin walking between 13-48 months whilst for typically developing children the range for this achievement is 9-17 months.

Despite such delays in motor development, children with Down's Syndrome do appear to follow a similar sequence in the acquisition of motor milestones (Carr, 1970). However, a number of studies suggest anomalies in the early postural control of children with Down's Syndrome. Children with Down's Syndrome often adopt unique positions or make unusual movements to maintain postural stability (Lydic & Steele, 1979). Rast and Harris (1985) found the postural reactions of children with Down's Syndrome to be less effective than typically developing peers. Evidence from Butterworth and Cicchetti (1978) supports this finding. Butterworth and Cicchetti report that the frequency of postural adjustments to visual proprioception followed a similar pattern to that observed in typically developing children. However, the magnitude of adjustments in the Down's Syndrome group were less effective than the typically developing group. Children with Down's Syndrome either over or undercompensated to visual stimuli.

As we have noted, there is evidence to suggest a link between motor and cognitive advances in typically developing children. Variability in achievement of motor milestones and differences in motor development may therefore have corresponding implications for cognitive development. A number of studies have pointed to the close correspondence between motor and cognitive development in children with Down's Syndrome (Cicchetti & Sroufe, 1976; Lenneberg 1966, 1967; Yessayan & Pueschel, 1984). Cicchetti and Sroufe found that hypotonia appeared be associated with a delay in the development of affective expression in children with Down's Syndrome. Lenneberg (1967) suggested that there is a close correspondence between motor and linguistic development in children with Down's Syndrome. Cicchetti and Beeghly (1990) argue that the co-occurrence of these problems across different domains may reflect a common central deficit. Yessayan and Pueschel (1984) report that the early quality of muscle tone in children with Down's Syndrome is a good predictor of competence in a number of domains.

There are a number of difficulties in establishing the independent contribution of motor delay to a deficit in sensorimotor development. Firstly, correlations between motor performance and cognitive tasks, as with studies of typically developing children, do not necessarily suggest a causal relationship between the domains. If, as Cicchetti and Beeghly suggest, the correspondence of motor and cognitive impairments reflect a common deficit, this deficit may simply be a global maturational delay. However, if it could be demonstrated that the correlation between cognitive and motor development is stronger than that with other domains it would add weight to the hypothesis that there are specific links between motor and cognitive development. However, given the evidence suggesting relative developmental coherence (e.g. Lenneberg, 1967; Cicchetti & Beeghly, 1990), indicators of motor development and developmental age are likely to be highly correlated in children with Down's Syndrome. Any discrepancy between the predictive value of motor milestones, and the predictive value of chronological and developmental age is therefore likely to be small. However, the widespread variability in developmental and motor milestones in children with Down's Syndrome may illuminate a specific link.

Motor performance and cognitive development are clearly associated in typically developing children. However, the consistent delay in the motor development of children with Down's Syndrome allows us to investigate the extent to which this relationship is causal rather than coincidental. Studies which demonstrate the equivalence of locomotor experience in baby walkers to unassisted locomotion point to a simple and effective intervention strategy (Gustafson, 1984; Kermoian & Campos, 1988). The importance of ascertaining whether the sensorimotor development of children with Down's Syndrome is limited particularly by deficient motor experience rather than general cognitive development is therefore particularly important from the point of view of intervention.

The aim of this study was to investigate the possibility that motor development and locomotor experience may predict sensorimotor performance in infants with Down's Syndrome. In order to ascertain whether motor development may independently contribute to sensorimotor performance, the predictive value of motor development was compared to the predictive value of chronological and developmental age.

9.2 Method

Questionnaires were sent to 27 parents of children with Down's Syndrome all of whom took part in other studies detailed in this thesis. Questionnaires asked parents to report significant dates for children's motor milestones i.e. ages when children belly-crawled, crawled, cruised using furniture as support, and took four steps unsupported. Parents were also asked to provide contact details for either a home teacher or physiotherapist who had clinical involvement with their child. A copy of the questionnaire is shown in Appendix D. 22 questionnaires were returned which represents a response rate of 81%.

Given that most children were the subject of routine clinical intervention, the reliability of parental responses regarding motor milestones was checked with physiotherapists. Four physiotherapists completed 12 questionnaires identical to those given to parents. The intra-class correlation coefficient (ICC(2,1)) was calculated for locomotor milestones as reported by physiotherapists and parents. The reliability for walking, cruising, and crawling were 0.85, 0.73, and 0.58 respectively. Where discrepancies existed in the reported onset of locomotor activity the figure reported by parents was used. Donoghue and Shakespeare (1967) found that parent's retrospective accounts of motor milestones were remarkably accurate.

Data on children's developmental status, both developmental age and sensorimotor performance, were collected as part of other empirical studies detailed in this thesis. A number of children had more than one developmental assessment since they took part in more than one of our empirical studies. Eight children had one assessment, 13 children had two, and one child had three assessments. The data comprised 6 assessments from study two, 15 assessments from study three, and 16 assessments from study four. In summary, our data comprise 37 developmental assessments from 22 children.

The BSID II was administered to determine children's developmental age on each testing occasion. The criteria for administration of the BSID II were consistent for all assessments although for study two and three, assessment was carried out on the first visit, while for study four, assessments were carried out on the second visit. Assessment of object permanence performance was carried out using a selection of items from the Uzgiris and Hunt scales (Appendix B). The assessment of object permanence was obtained on the first and second sessions for study two, on the first session for study three and on the second session for study four.

9.3 Results

9.3.1 Developmental age and motor milestones

At the time of developmental assessments children were at varying stages of motor and cognitive development. Given that for 14 children, repeated measures were available, descriptive statistics are presented for all 37 assessments rather than for the 22 children. This presentation is preferred for reasons of clarity and simplicity rather than statistical rigour. The mean interval between repeated assessments was 5.5 months with a range from 3.2 to 12.6 months. The chronological and developmental ages of the sample are shown in Table 9-1. Developmental milestones as reported by parents are also shown in this table, again as a mean of the data from 37 assessments (i.e. some children counted repeatedly).

	Mean (s.d.)	Min	Max.
Age at Assessment	25.5 (9.1)	12.0	44.0
Developmental Age	14.5 (4.7)	6.0	25.0
Age at Crawling	15.8 (5.5)	9.0	30.0
Age at Cruising	18.2 (5.2)	8.0	26.0
Age at Walking	23.3 (5.3)	15.0	32.0

Table 9-1: Chronological, developmental ages, and motor milestones of Down's Syndrome sample (37 observations)

The locomotor status of the sample at the time of testing is shown in Table 9-2 for all 37 observations.

Non-locomotor	Locomotor (Crawling or Cruising)	Locomotor (Walking)
5	12	20

Table 9-2: Locomotor status of the sample (37 observations)

Children are thus divided into three groups according to their locomotor status. One child in the sample was reported to have begun cruising before she began crawling. Given that we are specifically interested in the effect of locomotor experience on object permanence, this child was included in a general locomotor (crawling or cruising) group.

Given that the relationship between locomotor experience and sensorimotor performance may be restricted to the period prior to walking (Kermoian & Campos, 1988) data were examined from a subset of children who were not walking at the time of assessment. The developmental details for this subset of 11 children (17 observations) are shown in Table 9-3.

	Mean (s.d.)	Min	Max.
Age at Assessment	18.9 (5.6)	12.0	28.7
DA	11.1 (3.2)	6.0	16.0
Age at Walking	25.5 (5.8)	15.0	32.0
Age at Cruising	19.0 (5.5)	8.0	26.0
Age at Crawling	15.7 (3.8)	10.0	22.0

Table 9-3: Chronological and developmental ages and motor milestones of DS sample (non-walkers at test) (17 observations)

The duration of locomotor experience was calculated as the difference between chronological age at the time of assessment and the age of onset of crawling or cruising as reported by parents. Children not crawling or cruising at the time of assessment were deemed to have no locomotor experience.

The mean locomotor experience for the whole sample, and the non-walking sample, is shown in Table 9-4.

	Mean (s.d.)	Min	Max.
Locomotor experience (months) Whole sample (37 observations)	11.6 (9.2)	0.0	32.5
Locomotor experience (Months) Non-walking sample (17 observations)	5.1 (5.5)	0.0	18.7

Table 9-4: Locomotor experience (months)

9.3.2 Object permanence and motor milestones

Object permanence performance was tested during each study and the highest level of performance is indicated in Table 9-5 for each assessment.

Uzgiris and Hunt Task	<4	4	8	10	13	14	15
Sensorimotor Stage	<IV	IV	Late V	Early VI	VI	Late VI	Late VI
Non-locomotor n=5	1		4				
Locomotor n=12	1		5	5	1		
Walkers n=20			2	2	5	3	8

Table 9-5: Object permanence performance of the whole sample (37 assessments) by locomotor status

Performance on the object permanence tasks was converted to a score based on the most difficult task which each child passed. Given that there are six levels of task (Item 4 - Item 15) the maximum score achievable was six. A two-way analysis of variance was carried out for each combination of locomotor experience, developmental age, chronological age and object permanence score. In each case, the effect of subject identity (i.e. the within subjects effect) was included as a factor. Correlation coefficients were calculated from F ratios obtained in these analyses with the within subjects effects partialled out of the correlation.

Table 9-6 shows the correlation coefficients calculated for the 37 observations (top-right) and for the non-walking sample of 17 observations (bottom left). Correlation coefficients are generally higher in the whole sample as opposed to the non-walking sub-sample. This is perhaps not surprising given that there are fewer observations in the sub-sample. Central to the hypothesis of this study is that object permanence score should be predicted by locomotor experience. For the whole group the correlation between OP score and locomotor experience is no higher than that with chronological and developmental age. However, this result does suggest that locomotor development may predict object permanence scores at least as well as these other developmental measures. The high correlation between locomotor experience and chronological age reflects the fact that the locomotor experience is partially derived from chronological age.

	Locomotor Experience	Chronological Age	Developmental Age	OP Score
Locomotor Experience	-	0.96**	0.43	0.63*
Chronological Age	0.87*	-	0.82**	0.62*
Developmental Age	0.52	0.81*	-	0.60*
OP Score	0.19	0.24	0.20	-

*Table 9-6: Correlation coefficients with OP scores from regression analysis (shaded: 37 observations, unshaded: 17 observations) *p<0.05, **p<0.01.*

The regression coefficients and F-ratios from which the above correlation coefficients were derived are detailed in Appendix E.

Given that the current hypothesis predicts an independent contribution of locomotor experience to object permanence performance, correlation coefficients were calculated with either developmental age or chronological age partialled out. These coefficients are shown in Table 9-7.

	Controlling for Developmental Age	Controlling for Chronological Age
Whole Sample (n=37)	0.32 NS	0.16 NS
Non-Walking Sample (n=17)	0.10 NS	0.11 NS

Table 9-7: Partial correlation coefficients with OP scores (effect of age and developmental age partialled out)

Given the high correlations between the three predictor variables it is not surprising that these partial correlation coefficients are low. Although locomotor experience may relate to object permanence independent of developmental age, as indicated by the correlation of 0.32 for the whole sample, this coefficient did not reach significance.

Figure 9-1 illustrates, as a scatterplot, the relationship between performance on the object permanence tasks and locomotor experience at the time of testing. A number of anomalous results may pose a threat to any claim that there is a causal relationship between locomotor experience and object permanence development. Firstly it would appear that four months of locomotor experience is sufficient for performance at the highest level of object permanence, serial invisible displacement. Conversely however, one child with 18 months of locomotor experience had failed to progress beyond a score of 3, i.e. could not solve invisible displacement tasks.

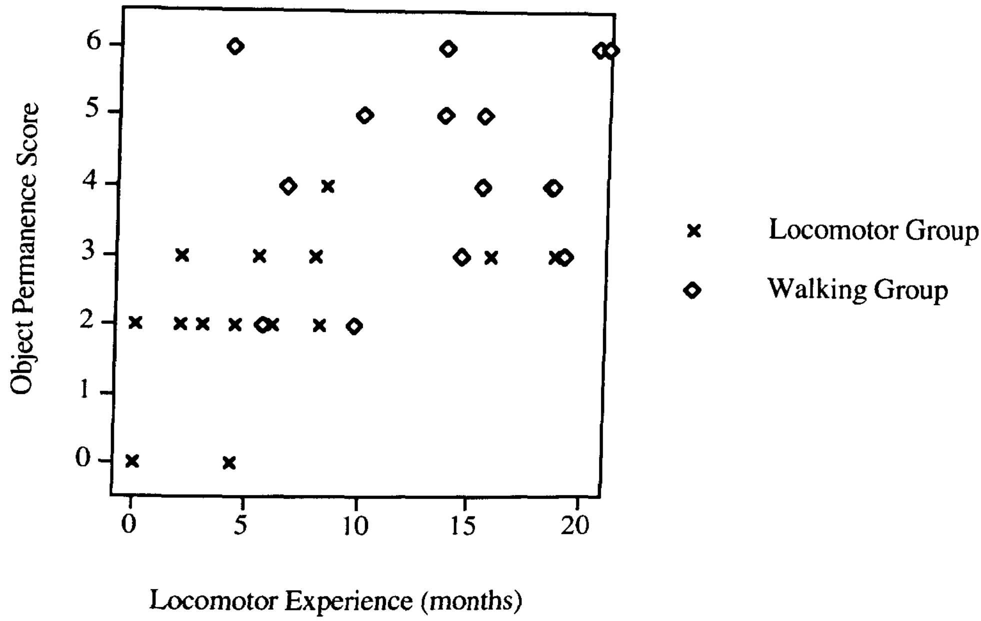


Figure 9-1: Scatterplot of OP scores vs. locomotor experience for 37 observations (22 cases)

Locomotor experience may be particularly important in only the early stages of object permanence development, where spatial factors are influential (Bremner, 1989). Any causal relationship between locomotor experience and object permanence development might therefore be restricted to tasks involving visible displacements such as the first two tasks. Even in this restricted sample there is an exceptional child who scored 2 in the absence of locomotor experience.

9.4 Discussion

The evidence suggests that in children with Down's Syndrome there does appear to be a relationship between object permanence development and locomotor experience. This result is consistent with other findings suggesting such a relationship in typically developing children (e.g. Piaget, 1955/1976). Given the high correlation between the predictors, locomotor experience, developmental and chronological age, it was not possible to isolate a specific and independent contribution of locomotor experience discernible from the effects of other predictors. However, in terms of correlations, the predictive value of locomotor experience does appear to be at least as strong as the other variables. Furthermore, the partial correlations indicate that locomotor experience may offer a contribution to object permanence development independent of other developmental variables.

The analyses which isolated a sub-sample of non-walkers did not reveal any significant effects. However, whilst it makes theoretical sense to limit inspection to a narrow window of sensorimotor development (cf. Kermoian & Campos, 1988) our sample size was clearly too small to illuminate any relationships.

Clearly, given the high correlation between locomotor experience and other developmental measures, this type of investigation requires a much larger sample. Furthermore, it may also be necessary, given the findings of Kermoian and Campos, to limit investigation to the first 14 weeks of locomotor experience. The Piagetian view of development suggests that during infancy, sensorimotor development should be explicitly linked to motor performance. The data presented here, while not explicitly counter to this claim, do suggest that apparent links between motor performance and sensorimotor development may be mediated to a large extent by other variables such as developmental and chronological age. Chronological age dependence in this case does not necessarily implicate endogenous maturational limitations but could also indicate dependence on particular environmental factors or experiences.

These findings do not strongly support the Piagetian view of sensorimotor development. However, a number of more specific claims have been made regarding the effect of early locomotor experience on spatial representations (Bremner, 1988; Horrobin & Acredolo, 1986; Kermoian & Campos, 1988). These studies suggest that early locomotor experience may be particularly influential in facilitating a transition away from egocentric spatial coding. This transition is theoretically seen as leading to success on visible displacement tasks involving more than one spatial location. Kermoian and Campos suggest that nine weeks of locomotor experience may be sufficient to ease the transition from stage IV to stage V i.e. from single location to multiple location search tasks.

However, evidence against a strong causal account of locomotor development as being necessary for advanced performance on object permanence tasks comes from a single exceptional child in the present study. This child was able to solve visible displacements with multiple covers despite not having begun to crawl. This would appear to indicate that children can gain sufficient experience of spatial relationships to solve stage V object permanence tasks whilst unable to crawl. This finding is consistent with case studies reporting near typical object permanence performance despite profound locomotor impairment (Gouin-Décarie, 1969). Such a finding is not however inconsistent with Kermoian and Campos's limited conclusion that locomotor experience may facilitate the development of spatial awareness rather than being a necessary prerequisite.

Kermoian and Campos restricted their analyses to children with less than 3.5 months locomotor experience. The data presented in this chapter are consistent with their findings within this range, although on the basis of a severely restricted sample size. Thus, there is no evidence against the more limited claim that children with nine weeks locomotor experience are more likely to solve stage V object permanence tasks. However, in our study, one exceptional child with five months locomotor experience was unable to solve any search tasks. However, the possibility that motor development may lag behind cognitive performance in children with Down's Syndrome certainly reduces the chances, in general, of finding such counter evidence (LaVeck & LaVeck, 1977).

In summary, we do not find support for a more general relationship between sensorimotor development and motor performance as proposed by Piaget (1955/1976). Our data suggest that there may be a relationship between early locomotor experience and the development of spatial awareness as indicated by stage V object permanence. There is thus limited evidence that self-generated locomotor experience may facilitate spatial representation in object permanence tasks. This finding, if confirmed in longitudinal intervention studies, may provide a valuable intervention to facilitate early cognitive development.

The apparent equivalence of self-generated, locomotor and baby-walker experience in facilitating success on search tasks (Kermoian and Campos, 1988) may prove to be important from the point of view of intervention. Kermoian and Campos also distinguished between belly crawling and hands and knees crawling and found the former to be less effective in facilitating performance. Whilst there are a number of plausible explanations for this finding it does suggest that different forms of locomotor development may have different experiential benefits. The effects, anomalies and delays reported for motor development in children with Down's Syndrome and the availability of practical intervention warrant further investigation.

Given the evidence presented here, there is no specific suggestion that locomotor experience is necessary for the representational development of object permanence. These findings are contrary to the Piagetian prediction that the two domains should be linked and suggest that findings in typically developing children may be coincidental.. The current results are however consistent with exceptional cases published elsewhere (Gouin-Décarie, 1969). It appears that the representational development in the object permanence domain is broadly typical in terms of its dependence on locomotor experience. This typical pattern is an accordance with the developmental coherence view of Down's Syndrome suggested by Cicchetti and Beeghly (1990). However, if the development of object permanence is genuinely coherent one would expect to find typical patterns in other cross domain relationships. In the next chapter, the links between representation in object permanence and language are investigated.

Chapter 10

Study 2: Object Permanence and Language Development

10.1 Introduction

Piaget's view of development as a domain general process in which early thought is linked to sensorimotor action leads to a number of hypotheses concerning links between early sensorimotor performance and linguistic development. Piaget believed that attainment of stage VI of sensorimotor development at around 18 months marked the emergence of the symbolic (or semiotic) function and hence the onset of symbolic thought facilitating language and symbolic play. However, empirical evidence has largely failed to support Piaget's general claim and the consequent limitations which it makes on the emergence of language (Corrigan, 1979; Gopnik, 1988; Harding & Golinkoff, 1970).

There are a growing number of theoretical accounts supported by evidence which both criticise and offer alternatives to Piaget's domain general view of language learning. Children learning a language face at least three problems according to Karmiloff-Smith (1992/1995): how to divide the speech stream into meaningful units; how to analyse the world into objects and events relevant to linguistic encoding; and how to organise the mapping between the units of speech and the objects and events. Nativists argue that the complexity of language with respect to these demands precludes the possibility that language can be learned without innate constraints. Furthermore, nativists argue that such is the specificity of these constraints that an innate cognitive module or device exists which is dedicated to meeting the demands of learning language.

Despite the persuasiveness of the argument for nativism with respect to grammatical structure in particular, there are a number of areas in which linguistic development could be dependent upon representations in the cognitive domain. It is widely accepted that there are a number of linguistic forms which map directly onto semantic relationships which themselves reflect the child's physical and social world. Pinker (1984, 1987) argues that the child's awareness of semantic categories facilitates a structural analysis of adult language. Pinker argues that without such 'semantic bootstrapping', the child would be unable to use an innate knowledge of grammar to understand language input. This bootstrapping process therefore serves to feed an innate language acquisition device such as that proposed by Chomsky (1965, 1982).

Thus a child's knowledge of the semantic roles of agent, actor, object, recipient and patient, could therefore be a necessary prerequisite for linguistic expression of these relationships. A number of approaches also suggest that more general semantic relationships may allow children to find a way into syntax (Tomasello, 1992; Bruner, 1977, 1978; Greenfield, Nelson, & Saltzman, 1972; Ferreiro & Sinclair, 1971). However, the semantic bootstrapping hypothesis, as espoused by Pinker, is focused on the means by which children begin to combine words to form sentences and understand the structure of combinations used by adults. A number of authors suggested a much earlier role for semantic and conceptual development in the acquisition of language, at the single word level (Brown, 1983; Bloom, 1983; Gopnik & Meltzoff, 1986; Tomasello & Farrar, 1986). Furthermore, some researchers have suggested that lexical acquisition at the one-word stage of language development may be a particularly important precursor to the acquisition of syntax (Tomasello, 1992; Anisfeld, 1984; Bates, Bretherton, & Snyder, 1988/1991).

Anisfeld (1984), and Bates et al. (1988/1991) suggest that the rate of lexical acquisition may predict the child's later grammatical development and the two processes may share a common underlying mechanism. Tomasello (1992) also argues that the roots of syntactic development may be in lexical acquisition. However, Tomasello emphasises the particular importance of verbs in feeding the development of syntax. Thus the semantic and conceptual precursors which govern the children's acquisition of lexical items may have implications for later grammatical development. In this chapter we describe an experiment to investigate the cognitive and semantic processes which govern lexical acquisition. The subsequent discussion addresses evidence from children with and without Down's syndrome in relation to these processes.

A number of specific claims have postulated that a high level of object permanence should be a prerequisite for lexical reference (Brown, 1973; Bloom, 1973). The rationale for this claim is that children must have well founded representations of objects before they can refer to them linguistically. However, despite the intuitive appeal of the hypothesis, empirical studies have failed to support a general relationship between linguistic measures (such as MLU or vocabulary size) and object permanence level (see Corrigan, 1979, for a review). Some authors have claimed that lexical advances are more strongly related to means-ends performance than to object permanence (Curcio, 1978; Mundy, Seibert & Hogan, 1984; Bates, Benigni, Bretherton, Camioni, & Volterra, 1979). McCune-Nicholich (1981a) suggests that, in any case, broad linguistic measures are likely to be influenced by a range of social-communicative factors which would overshadow the contribution of cognitive prerequisites. However, McCune-Nicolich reports that the emergence of specific features in children's vocabulary, such as relational words (those particularly referring to the 'dynamic state of objects'; such as *up, more, gone*) may be strongly related to object permanence development.

This view is summarised in Gopnik and Meltzoff's (1986) 'Cognitive Specificity hypothesis' which postulates links between development in specific domains, object permanence and means-ends, and related linguistic features. Gopnik and Meltzoff claim that the emergence of linguistic terms relating to the disappearance of objects, 'gone', 'more', etc., should be linked to a high level of object permanence. Furthermore, lexical terms expressing success or failure, such as 'uh-oh', 'no', should be related to performance on means-ends tasks. Gopnik and Meltzoff found a high correlations between acquisition of such terms and the related cognitive performance.

Work by Tomasello and Farrar (1986) broadly supports the findings of Gopnik and Meltzoff (1986), but suggests a further subdivision of relational words. Tomasello and Farrar argue that words expressing visible displacement (move, fall-down, etc.) should be distinguished form those expressing invisible displacement (gone, find, more, etc.). Furthermore, while visible displacement terms may emerge at stage V object permanence, invisible displacement terms should not emerge until stage VI when a concept of invisible displacement (stage VI) is acquired.

Tomasello and Farrar carried out a training study in order to add causal weight to their claim. Children at both stage V and stage VI were taught two nonsense words related to either a visible or invisible displacement. While children at stage VI were able to acquire both words, only the visible displacement term was acquired by the children at stage V. Tomasello and Farrar conclude that such evidence suggests that stage VI object permanence should be a cognitive prerequisite for acquisition of relational words referring to the invisible displacement of objects.

The equivocal evidence obtained in studies of typically developing children suggests that the general language-cognition relationship, if it exists, may be contaminated with a range of other cognitive and social factors (McCune-Nicholich, 1981a). Children with Down's Syndrome have a well documented delay in language development which exceeds the delay in general cognitive functioning. These children would therefore seem to provide an opportunity to empirically isolate linguistic and cognitive milestones. This pattern therefore affords a unique opportunity to investigate links, both general and specific, between language and conceptual development.

10.1.1 Language and cognitive development in children with Down's Syndrome

Children with Down's Syndrome have a well documented delay in cognitive, motor and language development. Language production (and especially syntax) tends to be more delayed than both comprehension and general cognitive development (Fowler, Gelman & Gleitman, 1994). Vocabulary acquisition is slower in children with Down's Syndrome than in normally developing children, even when the slower rate of cognitive development is accounted for (Mervis, 1990).

One potential explanation for a delay in linguistic representation in children with Down's Syndrome is that it arises as a consequence of a delay in sensorimotor prerequisites which form the basis of linguistic representation. Gibson (1978) claims that the transition from stage V to stage VI in general is a 'developmental wall' for children with Down's syndrome. Gibson reported that development was relatively rapid up to a mental age of 18 months, equivalent to the end of sensorimotor stage V, and reached a plateau before continuing to advance. However Gibson's results were based on general assessment of mental age rather than explicit measurement of performance on sensorimotor scales. More recent research has found the stage transition to proceed at a rate comparable to that of children without Down's syndrome, particularly when the slower rate of general development is accounted for (Mervis & Cardoso-Martins, 1984; Dunst, 1990).

However, while cognitive development is certainly delayed, language delays in children with Down's syndrome cannot be fully attributed to a delay in object permanence. Cardoso-Martins, Mervis and Mervis (1985) report that children with Down's Syndrome comprehended fewer object names upon attainment of stages V and VI object permanence than a control group of non-delayed children at the same stages of sensorimotor development. Therefore, despite possessing the requisite cognitive skills, and notably object permanence, children with Down's syndrome appear to have an additional difficulty in the expressive language domain.

Is it possible, therefore, that expressive language at the one word stage could be limited by 'cognitive factors'? The profile of children with Down's Syndrome, typified by relatively advanced sensorimotor skill, suggests that language development may be impaired by cognitive factors outside the sensorimotor domain. However it is possible that structural relationships in atypical populations may be different from those in typically developing populations. Therefore, while sensorimotor development may be a necessary condition for the acquisition of particular linguistic terms, the data on the development of children with Down's Syndrome raises questions about whether cognitive prerequisites are sufficient. Evidence for the failure to learn particular relational words despite the presence of sensorimotor prerequisites might suggest differences, either in the quality of such representations, or a breakdown in the link between cognitive and linguistic domains. Alternatively, adopting a domain specific view of language development, such evidence would imply that such cognitive factors are not solely responsible for delays in linguistic acquisition.

A number of researchers have pointed to qualitative differences and increased instability in the performance of children with Down's Syndrome on cognitive tasks such as the object permanence scale (Wishart & Duffy, 1990; Morss 1983, 1985). Evidence presented in chapter 8 failed to confirm these findings but, nevertheless, the suggestion of cognitive instability may have implications for acquisition of corresponding linguistic features. Gopnik and Meltzoff (1984) speculate that the link between cognitive and linguistic transitions may be influence by the 'salience' of particular cognitive achievements. If these achievements are rendered less salient through unstable or weaker representations then linguistic acquisition may be correspondingly impaired.

10.1.2 Aims

The general aim of this experiment was to study the relationship between conceptual representations in the cognitive domain and the acquisition of corresponding linguistic representations. The relationship between the development of object permanence and the acquisition of words related to the invisible displacement of objects was specifically investigated. In an attempt to identify a causal relationship between the development of object permanence and the emergence of relational words the methodology of Tomasello and Farrar (1986) was adopted.

In relation to children with and without Down's Syndrome, this experiment addressed a number of specific questions:

I. To what extent is stage VI of object permanence performance a necessary and sufficient condition for comprehension and production of an invisible displacement term?

II. To what extent is stable performance at stage VI of the object permanence scale necessary for the comprehension and production of an invisible displacement term?

III. a) To what extent is sensorimotor development related to the comprehension and production of linguistic reference to actions and objects. b) Is there general evidence for an association between cognitive and linguistic development in children with Down's syndrome?

10.2 Method

10.2.1 Participants

Children took part in this experiment as an adjunct to the methodological investigation detailed in Chapter 8. 12 children with Down's syndrome and 12 typically developing children from a range of socio-economic backgrounds made up the sample for this study. Table 10-1 show the chronological ages, birth order, and gender of participants from both groups.

	CA	Birth Order	Gender
		1st 2nd 3rd	female:male
DS (n=12)	31m (18m - 52m)	5 : 5 : 2	7 : 5
NDS (n=12)	19m (14m - 21m)	7 : 3 : 2	7 : 5

Table 10-1: Mean chronological age (CA), birth order, and gender of participants

Table 10-2 shows the mean developmental ages for both the DS and NDS groups. Developmental age was calculated as the mean of two developmental assessments with the Bayley Scales (2nd edition) carried out at the beginning and at the end of the training study (these assessments were 3 weeks apart). These data were also reported in chapter 8.

	Mean DA (range)
DS (n=12)	18m (12m-29m)
NDS (n=12)	19m (13m-26m)

Table 10-2: Mean developmental ages of participants

Language development was assessed using the MacArthur Communicative Development Inventory (CDI) (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993). This questionnaire was completed by parents after the first visit. An extra word 'spin' was included in the questionnaire in order to assess the children's naturalistic acquisition of this lexical term as an adjunct to the training regime described below. For children with Down's syndrome, a checklist measure of the number of Makaton signs used was also administered. Table 10-3 shows the age equivalent scores for language comprehension and production assessed using the MacArthur CDI. For the children with DS, the mean number of Makaton signs produced is also shown.

	Language Comprehension Age	Language Production Age	Number of Makaton signs produced
DS (n=12)	14m (1.5m)	15m (6m)	39 (38)
NDS (n=12)	17m (1m)	18 months (6m)	N/A

Table 10-3: Assessment of language comprehension and language production, MacArthur CDI age equivalent scores, and mean no of Makaton Signs produced. (standard deviations in brackets).

When comparing the two groups, language comprehension and production scores were significantly different only for the comprehension measure ($t= 2.178$ $DF=22$ $p<0.05$). However, given the relatively large standard deviations in production for both groups, the lack of a significant difference in production is hardly surprising. The large standard deviation in the number of Makaton signs produced by the DS group reflects the fact that while some children are encouraged to learn Makaton, others are not (two children did not produce any Makaton signs).

10.2.2 Procedure

Children were visited for eight, twice weekly sessions, over a period of four weeks. During the first and last session, children's developmental ages were assessed using the Bayley scales of infant development. During the intervening six sessions, children were trained in, and tested on, the comprehension and production of lexical terms as outlined below. At the close of each session, sensorimotor development was assessed using object permanence and mean-ends scales from Uzgiris and Hunt (1975). Modified versions of each scale were administered three times over six sessions (see Appendix B). The protocol for the administration of these items is detailed in chapter 8.

Lexical training took place over three weeks with two training sessions per week. Sessions were arranged at a convenient time for the parents and the experimenter emphasised the need to select a time at which the child would be alert. There was an interval of at least one day between sessions.

During each session, children were taught lexical terms referring to the displacement of objects. The objects used in the experiment are shown in Figure 10-1.

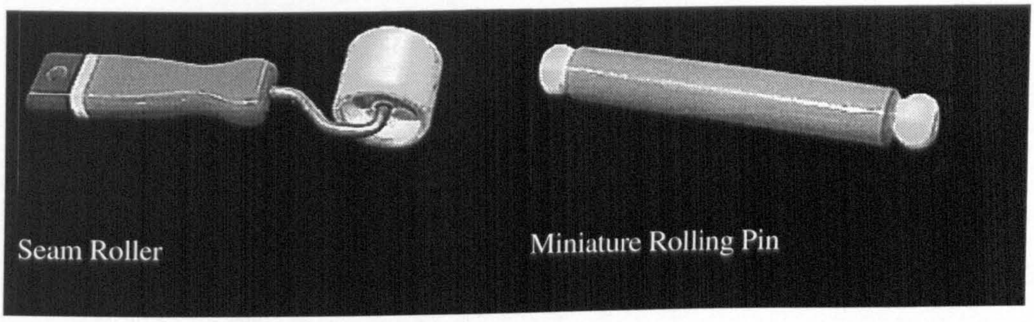


Figure 10-1: Objects used in the experiment

Objects were intended to be novel to the children taking part and parents were asked to confirm that the objects were unfamiliar to their children. Children were taught two nonsense words 'deke' and 'dop' which related to the visible and invisible displacements of the objects. Visible displacement of the objects entailed spinning them by hand about the vertical axis through the plane of the object. Invisible displacement entailed hiding the object under a brightly coloured cloth so that it could not be seen by either the experimenter or the child. The words 'deke' and 'dop' were assigned to actions prior to the training and the combinations of word and action were counterbalanced between subjects. The objects were labelled with nonsense words from a selection provided by Schwartz and Leonard (1982). Particular words were selected to match the child's current productive phonology as reported by parents as this may have influenced their acquisition. In the absence of any information from parents on the child's production of phonological forms, two nonsense words with open syllabic structure (CV or CVCV) were chosen by the experimenter.

10.2.2.1 Lexical training

Lexical training was carried out as by Tomasello and Farrar (1986). The general training procedure consisted of the experimenter performing acts with the objects which were labelled using nonsense words as follows:

> 'Watch the bob deke', for the first action, and 'Watch the bob dop', for the second action. Visible and invisible displacements were assigned to first and second actions with the particular pairing being counterbalanced between children. Each action was demonstrated twice in this manner.
>
> After demonstrating four actions with the first object, the procedure was repeated with the second object as follows: 'Watch the osh-osh deke' (*2), and 'Watch the osh-osh dop' (*2).

Attempts were made to maintain the child's attention throughout the labelling procedure and children were directed both verbally (calling 'look' or the child's name) and physically (following the direction of child's gaze). Following the training period which lasted a maximum of 15 minutes, the child's comprehension and production of the target words was tested as described in the next three sections.

10.2.2.2 Lexical assessment: comprehension testing

To assess comprehension of object names, children were presented with the two objects and asked to find one of them. The experimenter would ask, for example, 'Where's the osh-osh?' or, 'Show me the osh-osh'. These questions were followed by similar requests about the second object name.

To assess comprehension of action words, children were asked to perform the actions with each object in turn, 'Make the osh-osh deke' followed by the second action, 'Make it dop'. These questions were followed by the same questions about the second object.

Assessment of children's comprehension was followed by assessment of their lexical production.

10.2.2.3 Lexical assessment: elicited production

To elicit production of object names children were asked 'What's this?', while the experimenter held up an object, followed by the same question about the second object. For production of action words, children were asked, 'What's the osh-osh doing?', or, 'What happened?', while the experimenter performed one of the actions. This question was asked for each object - action pairing i.e. 2 objects, 2 actions, and a total of four questions. In all cases each question was repeated up to three times if the child made no response. Correct responses to these questions are referred to as 'elicited production'.

10.2.2.4 Lexical assessment: spontaneous production

Children's spontaneous imitative and non-imitative utterances of target words and actions were also scored. The target words were the two object names and the two action words as recognised by the experimenter viewing the video tape. The minimal conditions for production of a target word were production of either a vowel or consonant matching that of the target word. A word was rated as imitative if it occurred within 5 seconds of its use by the experimenter and with no intervening utterance by the experimenter or child. Other utterances were rated as non-imitative.

10.2.2.5 Treatment of results

Children's responses were rated by the experimenter from video tapes of the sessions. For comprehension, responses were deemed to be correct if, in the case of the object words, the child selected the correct object, or, in the case of action words, successfully performed the correct action (spinning or hiding). Responses for comprehension of target words, including object words, and the visible and invisible displacement words, were scored out of a total of 2 per session (2 responses for each word). Conservative criteria were adopted in the scoring of the child's responses. Responses were scored as correct only for responses which were both correct and exclusively given in response to the appropriate question. Thus, if a child simply hid the object in response to both, "can you make it deke?' and 'can you make it dop?' the child would not score for action word (invisible) comprehension. Similarly conservative criteria were adopted for scoring the production of action words and comprehension and production of object names. Maximum scores for production questions were 2 for each action word (2 per session). Scores for objects names were combined and the maximum score was again 2 per session (1 per session x 2 objects).

Inter-rater reliability of comprehension, production and spontaneous utterance frequency was assessed for a randomly selected 10% of the video taped sessions. A second rater, a graduate psychologist, rated the tapes according to the above criteria. The interclass correlations, ICC(2,1), were 0.76 for judgements of comprehension and 0.63 for judgements of production. The interclass correlation for spontaneous utterances was 0.64.

10.3 Results

Sensorimotor development was assessed in terms of means-ends and object permanence scales. Children were categorised as either stage V or stage VI according to their performance on the object permanence scales. This classification was made on the basis of children's performance on item 15 of the scales involving the serial invisible displacement of an object under three covers. This item was used as it requires children to have a firm conceptual basis for understanding the invisible displacement of objects, and is consistent with the procedure adopted by Tomasello and Farrar (1986). Given that the stage VI task was administered on three occasions, we adopted the criterion of 2/3 passes to be classified as stage VI.

	Stage V		Stage VI	
	N	DA (s.d.)	N	DA (s.d.)
DS (N=12)	7	14m (1m)	5	22m (2m)
NDS (N=12)	6	16m (2m)	6	21m (2m)

Table 10-4: Developmental age (DA) of children by group: classified at stage V or stage VI object permanence

Table 10-4 shows the sample sizes and developmental ages for children classified at either Stage V or Stage VI of object permanence. A two way analysis of variance (group x stage) was carried out on developmental ages. This analysis suggested a significant difference in developmental age between stage V and stage VI, ($F(1,20)=21.66$, $p<0.001$), but the main effect of group, and the group x stage interaction, were non-significant, $F(1,20)=0.13$, $p=0.73$, and $F(1,20)=0.99$, $p=0.33$ respectively.

10.3.1 Object permanence and relational verb learning

The primary aim of this study was to determine the extent to which performance of stage VI object permanence is a necessary prerequisite to acquisition of a relational word referring to the invisible displacement of an object.

Table 10-5 shows the mean comprehension scores for the DS and NDS groups. The means suggest, at least for comprehension, that children with Down's syndrome acquired both words with a similar frequency to the NDS group.

Group	Invisible displacement ('gone' word)	Visible displacement ('spin' word)
DS	3.6 (4.8)	3.2 (4.1)
NDS	3.0 (4.5)	3.5 (4.4)

Table 10-5: Mean comprehension score by group and word type - max. score 12 (s.d.)

A three way analysis of variance (group x word type x session) showed no main effect of group ($F(1,22)=0.01$, NS) or word-type ($F(1,22)=0.01$, NS), or session ($F(5,110)=1.74$ NS). The group x word type interaction was not significant ($F(1,22)=0.61$, NS).

Figure 10-2 shows the comprehension scores for both invisible (gone) and visible displacements (spin). This figure shows the relationship between stage of object concept development and word comprehension. For children with DS there appears to be an improvement in comprehension of the invisible displacement word but not the visible displacement word between stage V and VI. This result is similar to that obtained by Tomasello and Farrar (1986) for normally developing children. However, for the NDS group, a more general improvement is observed for both invisible and visible displacement words.

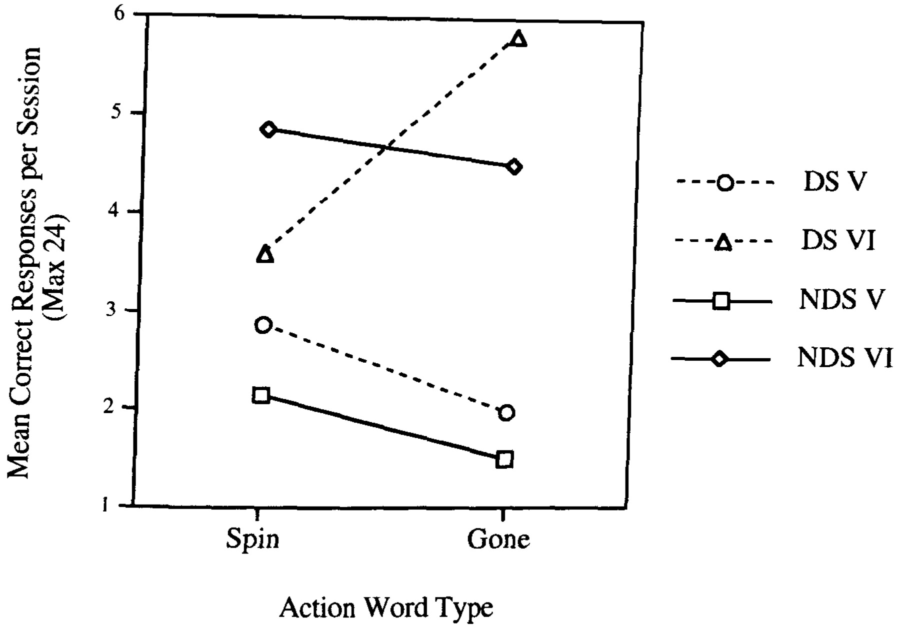


Figure 10-2: Mean correct comprehension responses for DS and NDS groups by sensorimotor stage (V & VI) and word type.

A four way analysis of variance (group x word type x object permanence stage x session) revealed a significant effect only for object permanence stage $F(1, 21)=27.0$, $p<0.001$. The main effect of word type was not significant $F(1,21)=0.01$, NS. Furthermore the predicted interaction, word type x stage, was not significant $F(1,21) = 1.91$, NS. Given the small sample size and the trends in the Down's Syndrome group, the power of the current analysis was compared to that in Tomasello and Farrar's (1986) study. For the data presented in this study, $\eta^2 = 0.10$, and power = 0.60 i.e. the probability of a type II error $\beta= 0.30$. In contrast, for Tomasello and Farrar's data $\eta^2 = 0.17$, and power =0.84 i.e. the probability of a type II error $\beta= 0.06$ (calculated from Cohen, 1988). Thus, the effect sizes in the present study are smaller than the effects obtained by Tomasello and Farrar. Furthermore, this result indicates the need for a larger sample size if effects are to be detected.

Tomasello and Farrar used liberal criteria in the assessment of comprehension and production responses (Tomasello, personal communication) such that a child was credited with a correct score even if the correct response was not exclusively given in response to the appropriate question. Our analysis adopted a more conservative approach in which the child was required to respond with an appropriate action produced *exclusively* in response to the appropriate question. The results for the NDS group in the current sample were compared with those presented by Tomasello and Farrar using 'liberal' criteria for demonstration of comprehension.

Figure 10-3 shows our results for the NDS group according to liberal criteria with results from Tomasello and Farrar shown for comparison.

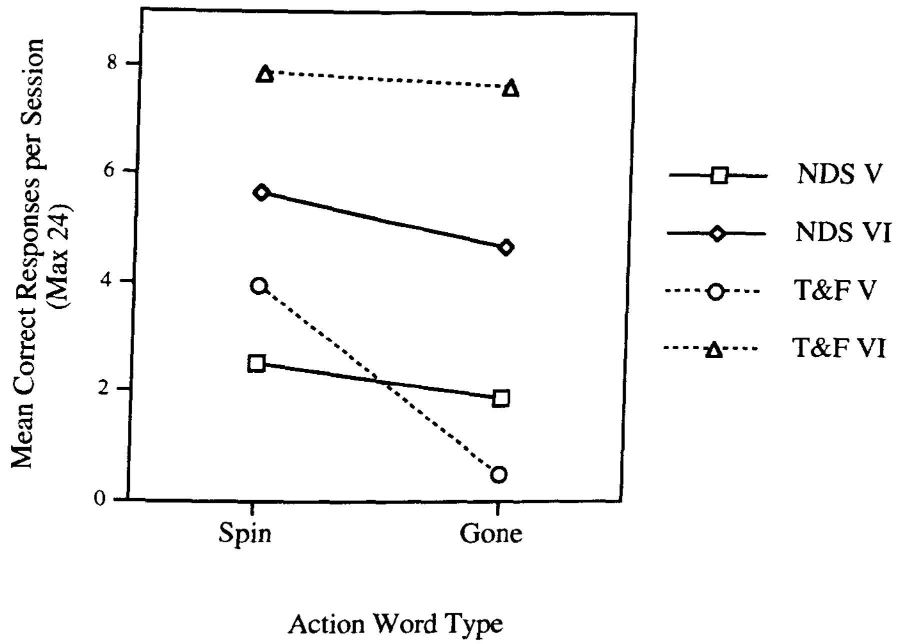


Figure 10-3: Mean comprehension scores for NDS group by word type and sensorimotor stage (liberal scoring criteria). Data from Tomasello & Farrar (1986) is shown for comparison[1]

[1] The y axis in this figure is based on mean comprehension scores per group per session (i.e. max. 24). This data from the Tomasello and Farrar study has been pro-rated (according to the number of participants) to facilitate direct comparison.

A three way analysis of variance (study x sensorimotor stage x word type) was carried out using weighted means and standard errors reported by Tomasello and Farrar. This analysis revealed an interaction of study x stage ($F(1,23) = 6.90$, $p<0.05$ reflecting the less dramatic stage effect in our NDS sample. No further interactions between study and other factors reached significance. This analysis suggest that the pattern of our findings in relation to the stage x word-type interaction does not differ from the results of Tomasello and Farrar.

Tomasello and Farrar claim suggest that performance at stage VI of object permanence should be a conceptual prerequisite for acquisition of 'gone' but that 'spin' could be acquired at an earlier stage. This implies that children below stage VI of object permanence should not be able to comprehend the invisible displacement word. Figure 10-4 shows the number of children reaching criteria for action word comprehension at stage V. While children in the NDS group conform to Tomasello and Farrar's prediction, two children in the DS group appear to have acquired 'gone' prior to attainment of stage VI.

Figure 10-5, shown for comparison, represents the number of children reaching criteria for action word comprehension at stage VI of object permanence performance. At this stage, Tomasello and Farrar imply that children should be in possession of the necessary prerequisites and should be able to acquire both 'gone' and 'spin'. The majority (3/5) children in the DS group and half of the children in the NDS group reached criteria for comprehension of 'gone'.

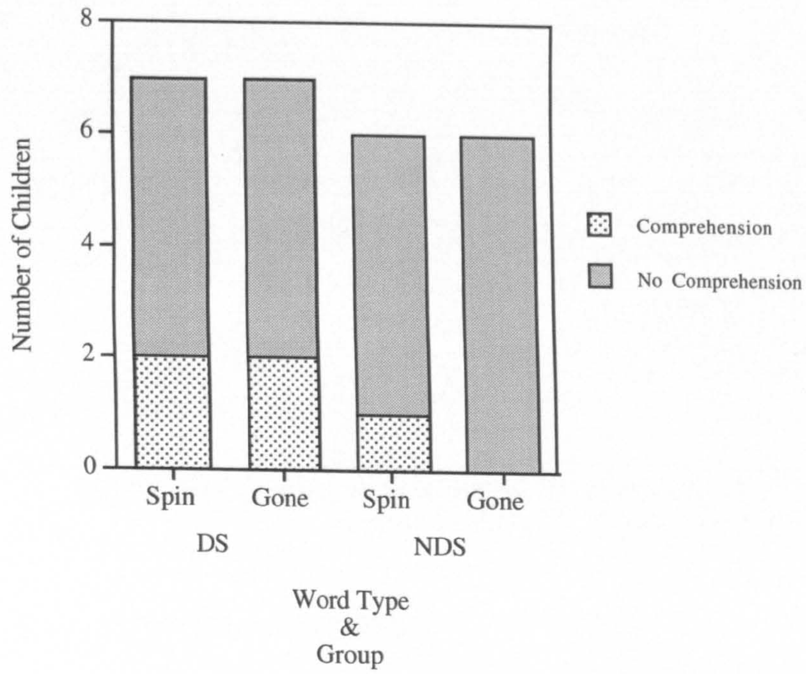


Figure 10-4: Number of children reaching comprehension criteria at object permanence stage V

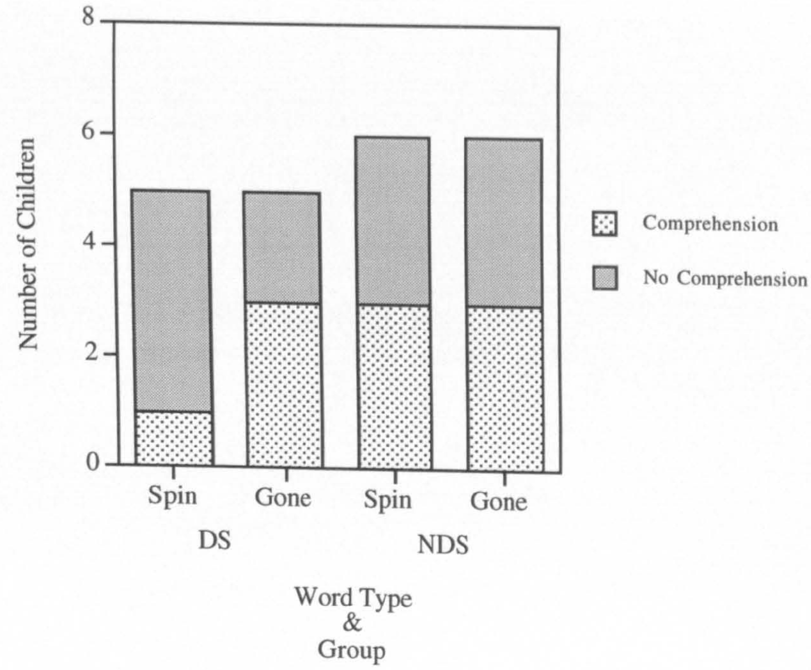


Figure 10-5: Number of children reaching comprehension criteria at object permanence stage VI

10.3.1.1 Action words: production

Children rarely produced the correct responses to the elicited production questions. Only 4 responses to the 144 elicited production questions were scored as correct: 3 responses in the NDS group, and 1 response in the DS group. These low frequencies are consistent with Tomasello and Farrar's data. However, children did produce spontaneous, non-imitative, utterances of the target action words 'deke' and 'dop'. Figure 10-6 shows the frequency of spontaneous (non-imitative) utterances by group and object permanence stage. There appears to be an improvement in utterance frequency corresponding to the transition from stage V to stage VI. For children with DS the increase is in utterances of the invisible displacement word, 'gone'. For the NDS group, the increase in utterances is much greater for the visible displacement word, 'spin'. The trends shown in spontaneous non-imitative utterances indicate an improvement with sensorimotor development similar to that which is apparent in the comprehension data (Figure 10-2). Furthermore, for the DS group, the improvement in spontaneous production of action words follows the pattern observed in comprehension.

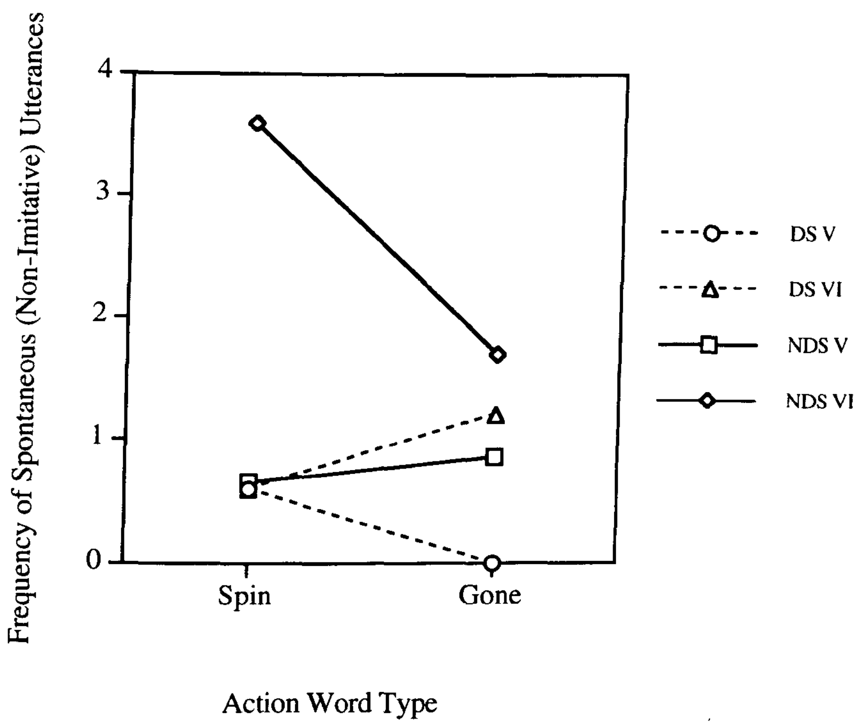


Figure 10-6: Mean frequency of spontaneous non-imitative utterances of target words relating to visible and invisible displacement

A four way analysis of variance (group x object permanence stage x word type x session) was carried out. The main effects of group, stage, word type and session were non significant ($F(1,20)= 1.95$, NS; $F(1,20)=2.51$, NS; $F(5,100)=0.67$, NS; $F(1,20)=0.43$, NS respectively). There were no significant interaction effects.

10.3.1.2 Contemporaneous language development

The naturalistic levels of relational word production for 'spin' and 'gone' were assessed using the MacArthur CDI. While 'gone' is a standard item in the inventory, 'spin' was specifically included in the inventory for the purposes of this study.

Figure 10-7 and Figure 10-8 show the number of children producing the words 'gone' and 'spin' according to parental report at the time of testing. In contrast to the findings of

Gopnik and Meltzoff (1986), 'gone' appears in children's vocabulary before stage VI. There does however appear to be an increase in production of 'gone' corresponding to the transition from stage V to stage VI of object permanence. While 'spin' is certainly a lower frequency word in children's, as in adult's vocabularies, two children in the NDS group at stage VI acquired the spin word. When asked about the context of children's production of 'spin', two parents reported that children's production reflected a routine game, 'spin me'. The results for the spin word are particularly informative in that children across both groups showed a similar pattern in the comprehension of the visible displacement during lexical training.

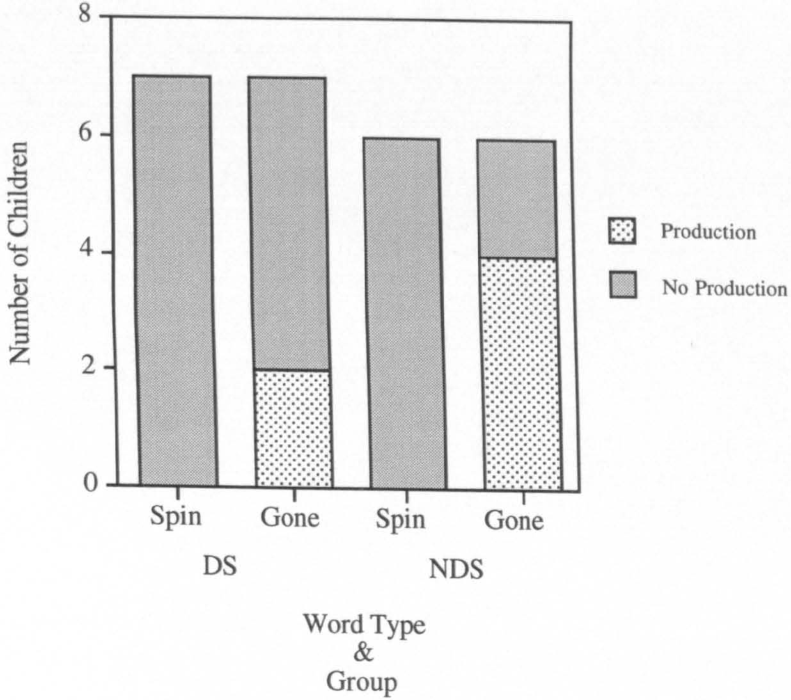


Figure 10-7: Production of 'gone' and 'spin' at stage V: DS and NDS Groups

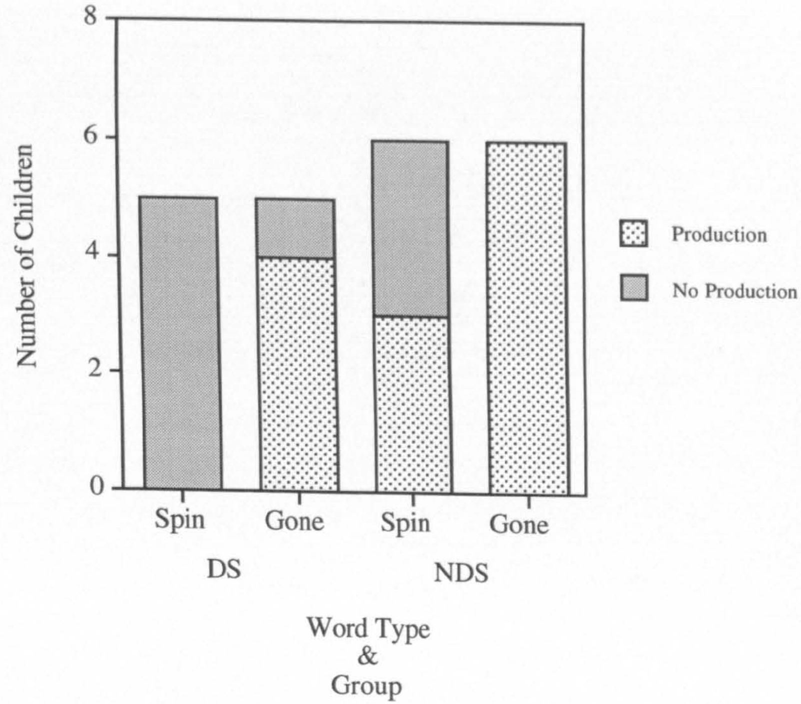


Figure 10-8: Production of 'gone' and 'spin' at stage VI: DS and NDS Groups

10.3.2 Object permanence, performance stability, and relational verb learning

The second aim (II) of this study was to evaluate the potential effects of instability in sensorimotor performance on corresponding linguistic features. Tomasello and Farrar's (1986) claim focuses on stage VI object permanence as a prerequisite for acquisition of relational words referring to invisible displacement. In order to elucidate whether the stability of children's performance on stage VI object permanence tasks would influence their acquisition of action words, children were divided into 4 groups according to the stability of their performance on the task corresponding to stage VI. Object permanence was assessed on three occasions. Children were therefore categorised according to their mean score on this task over the three testing sessions. The resulting mean scores of 0, 0.33, 0.67, 1.0, represent success on 0, 1, 2, and 3 occasions respectively. Table 10-6 shows the number of children in each group while Table 10-7 shows the developmental ages of these groups.

Passes	0	1	2	3
Stage VI Score	0.00	0.33	0.67	1.0
DS	5	2	2	3
NDS	3	3	2	4

Table 10-6: Number of children in groups by stability index

Stage VI Score	0.00	0.33	0.67	1.0
DS	13.6	21.0	16.5	23.3
	(2.1)	(7.1)	(0.7)	(4.6)
NDS	14.7	18.0	19.5	22.5
	(2.9)	(2.0)	(3.5)	(3.7)

Table 10-7: Developmental ages by stability index

Figure 10-9 and Figure 10-10 illustrate the relationship between stage VI performance and the acquisition of relational words. Both figures appear to show an increase in comprehension corresponding to increasing stability of object permanence performance with unstable performance resulting in intermediate scores on the word learning task.

A three way analysis of variance (group x stage VI x word-type) showed no main effect of group on word learning $F(1,16)= 0.46$, NS. However, the effect of stage VI performance was significant, $F(3,16) = 3.36$, $p<0.05$, suggesting a general improvement in word comprehension with increasing stable performance on the stage VI task. The interaction Stage VI x word type was not significant $F(3,16)=0.3$, NS. The three way interaction was not significant $F(3,16)=0.3$, NS.

The improvement in comprehension of 'gone', corresponding to improved performance of stage VI task, is reflected in the correlations between stage VI sensorimotor score and comprehension scores for action words shown in Table 10-8.

	Gone	Spin
DS	0.63 *	0.39
NDS	0.53	0.56

*Table 10-8: Correlations between comprehension scores and sensorimotor scores (stage VI) *p<0.05*

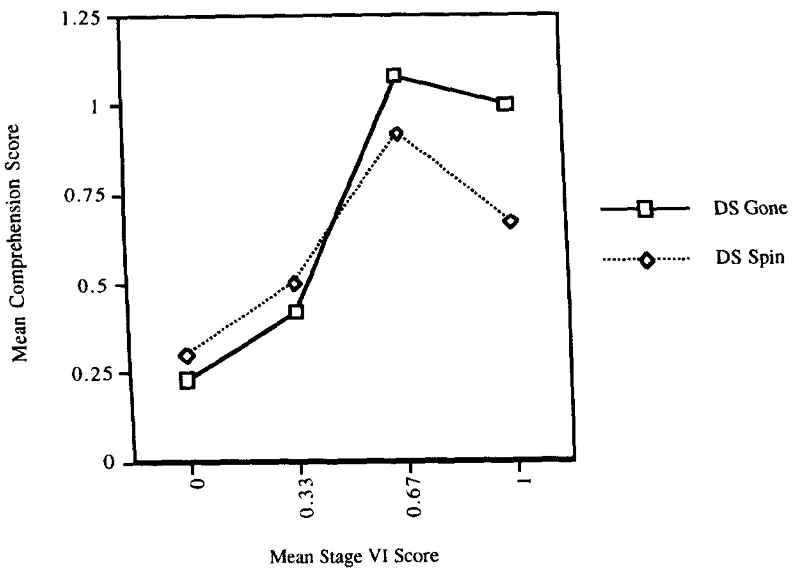


Figure 10-9: Mean comprehension scores for action words vs. score at stage VI: DS Group

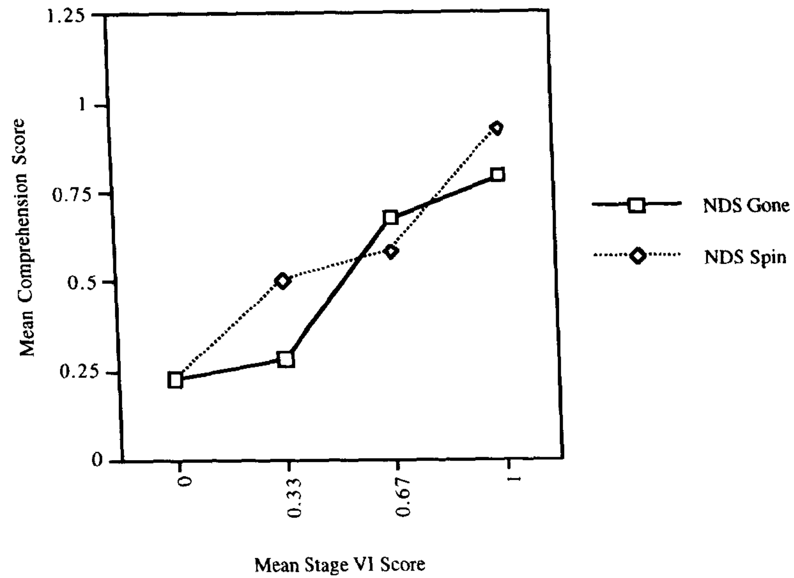


Figure 10-10: Mean comprehension scores for action words vs. score at stage VI: NDS Group

Table 10-9 and Table 10-10 show the relationship between stability on stage VI Object Permanence tasks and attainment of criteria for comprehension (as described previously in section 10.3.1). Once again instability in performance on the sensorimotor task appears to result in intermediate performance on word acquisition. If stable performance on object permanence tasks was a necessary prerequisite for comprehension of gone then children performing correctly on only one or two of the three task administrations would fail to reach comprehension criteria. In the DS group, 3 children out of a total of 4 reached comprehension criteria despite instability in their cognitive performance. In the NDS group, 2 children out of a total of 5 reached comprehension criteria despite such instability.

Stage VI Score	0.00	0.33	0.67	1.0
Gone	1/5 (20%)	1/2 (50%)	2/2 (100%)	3/3 (100%)
Spin	2/5 (40%)	2/2 (100%)	2/2 (100%)	2/3 (67%)

Table 10-9: Proportion of children comprehending words by stability index: DS group

Stage VI Score	0	0.33	0.67	1.0
Gone	1/3 (33%)	1/3 (33%)	1/2 (50%)	3/4 (75%)
Spin	0/3 (0%)	2/3 (67%)	1/2 (50%)	3/4 (75%)

Table 10-10: Proportion of children comprehending words by stability index: NDS group

10.3.3 Sensorimotor development and word learning

The final aim (III) of this empirical study was to investigate the general relationship between sensorimotor and linguistic performance beyond the specific claims made by Tomasello and Farrar (1986). In this section sensorimotor development as indicated by object permanence and means-ends performance is addressed in relation to acquisition of lexical reference to actions and objects.

10.3.3.1 Action comprehension, means-ends and object permanence

Analysis so far has focused on the theoretical relationship between action word comprehension and object permanence performance in particular. Table 10-11 shows the correlation between action word comprehension scores and scores on both object permanence and means-ends scales for the DS and NDS groups.

Scale		OP		ME	
Group		DS	NDS	DS	NDS
Word	Gone	0.70 *	0.57 *	0.68 *	0.63 *
	Spin	0.33	0.44	0.36	0.34

Table 10-11: Correlation coefficients between word comprehension scores and sensorimotor scale scores for DS and NDS groups (p<0.05)*

Children with and without Down's Syndrome show a strong relationship between sensorimotor performance and action word learning. While overall, the relationship between sensorimotor performance and acquisition of 'gone' is a strong one, the relationship is not restricted to the object permanence scale. In contrast, the relationship between sensorimotor performance and acquisition of the control word 'spin' appears to be weaker in general and is non-significant in all cases.

Correlation coefficients between sensorimotor development and invisible displacement, 'gone' word learning, are shown in Table 10-12. In this case the relationship between sensorimotor development and acquisition of 'spin' has been partialled out. The purpose of this partial correlation is to account for the, potentially artefactual, effect of general cognitive development on lexical acquisition, responsible for acquisition of 'spin', and to isolate cognitive prerequisites specifically pertinent to the acquisition of 'gone'. According to Tomasello and Farrar (1986), and Gopnik and Meltzoff (1986), acquisition of 'gone' should be correlated with object permanence performance but the acquisition of spin is not necessarily related to the same conceptual basis.

Scale	OP		ME	
Group	DS	NDS	DS	NDS
Gone	0.65 *	0.43	0.61 *	0.57

Table 10-12: Correlation coefficients for 'gone' word comprehension and sensorimotor scale scores for DS and NDS groups ($p<0.05$) - correlation with 'spin' word partialled out*

Table 10-12 shows a significant positive correlation between means-ends and object permanence performance and acquisition of the invisible displacement term for children with Down's Syndrome (DS). The correlations for children without Down's Syndrome (NDS) are smaller and did not reach significance.

10.3.3.2 Object words: comprehension

The most general claim regarding links between object permanence and lexical acquisition is that object permanence should be a prerequisite for lexical reference to objects. The relationship between object permanence and lexical acquisition during training will now be investigated.

Scores for comprehension of object names were assessed by asking children to point to the correct object when labelled by the experimenter. There were two objects and the maximum score for object word comprehension was 12. Figure 10-11 shows object comprehension scores for each group according to stage of object concept development.

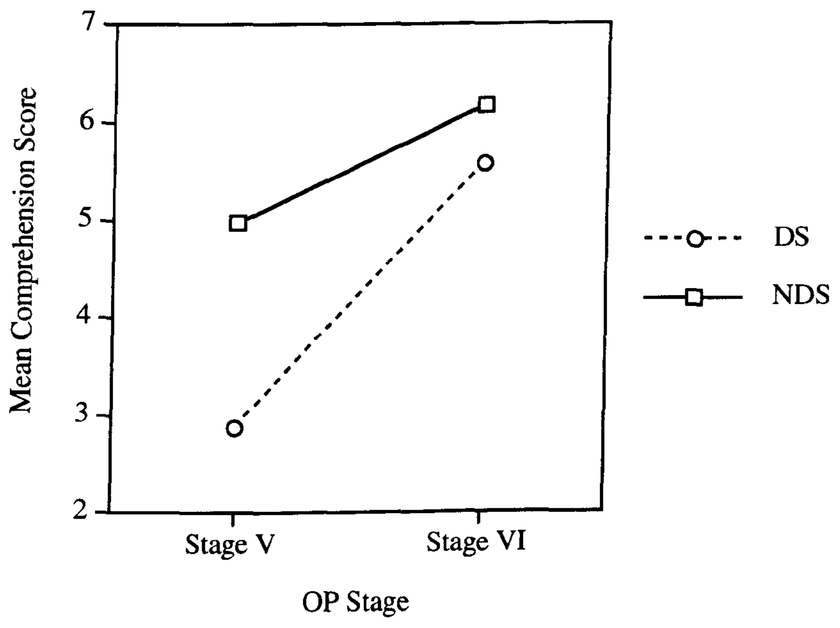


Figure 10-11: Comprehension scores for object words by group and by cognitive stage (maximum 12)

A three way analysis of variance (group x stage x session) was carried out on object comprehension scores. The main effects of group, stage and session were not significant ($F(1,20)=2.74$; $F(1,20)=3.49$; $F(1,20)=0.72$). There were no significant interaction effects.

10.3.3.3 Object words: elicited production

Table 10-13 shows the scores for elicited production of object names by performance on the object permanence scales. It is apparent that production scores are higher in the NDS group and there is a marginal stage dependent improvement across both groups.

OP Stage	V	VI
DS	0.0 (0.0)	0.2 (0.5)
NDS	0.3 (0.7)	0.7 (0.9)

Table 10-13: Score per session for elicited production of object words (max. score =2)

A three way (group x session x OP stage) was carried out on scores for the elicited production of object names. The main effect of group $F(1,20)=5.28$, $p<0.05$ reflects the higher production scores in the NDS group. Main effect of object permanence stage ($F(1,20) = 3.53$) and session ($F(1,20)=2.26$) were not significant. None of the interactions was significant.

10.3.3.4 Object words: spontaneous production

Table 10-14 shows the mean frequency of spontaneous utterances of object names in the DS and NDS groups. The spontaneous utterances follow a similar pattern to that of the elicited measure, with children in the NDS group producing more frequent utterances. Furthermore, there appears to be a general stage effect in object word production across both groups.

OP Stage	V	VI
DS	0.6 (1.2)	11.4 (16.8)
NDS	6.0 (9.0)	17.4 (16.2)

Table 10-14: Mean frequency (per child) of spontaneous (non-imitative) object word utterances by object permanence stage

A two-way ANOVA (group x stage) showed a significant effect for sensorimotor stage $F(1,20)= 5.09$ $p<0.05$. This effect shows an increase of spontaneous non-imitative production of object words from stages V to VI which closely parallels object word comprehension. The group effect and the group x stage interaction were not significant ($F(1,20)=1.33$, NS; $F(1,20)= 0.06$, NS).

10.3.3.5 Sensorimotor development and contemporaneous lexical development

This final analysis examines the relationship between object permanence development and lexical reference as measured by the MacArthur CDI. Table 10-15 shows the number of words comprehended and produced by children as measured by the CDI. In contrast to the age equivalent scores presented earlier in Table 10-5 these raw scores avoid introducing additional noise to the data. There are clear effects in terms of group and sensorimotor stage.

Group	Measure	Object Permanence Stage	
		V	VI
DS	Comprehension	149 (58)	191 (83)
	Production	17 (14)	67 (74)
NDS	Comprehension	190 (64)	268 (30)
	Production	30 (32)	171 (111)

Table 10-15: Productive vocabulary size in words by sensorimotor stage (s.d.): DS and NDS groups

A two way analysis of variance (group x stage) was carried out separately for comprehension and production scores. There was a main effect of object permanence stage for comprehension ($F(1,20)=5.91$, $p<0.05$) and for production ($F(1,20)=12.05$, $p<0.01$). These main effects indicate an increase in the children's vocabularies corresponding to the stage transition. Furthermore, the main effects of group were significant for comprehension ($F(1,20)=5.61$, $p<0.05$) and for production ($F(1,20)=4.48$, $p<0.05$) reflecting lower comprehension and production scores in the DS group. There were no significant interactions in either analysis.

Crucially however, when these data were reanalysed with developmental age as a covariate, all main effects were no longer significant. Thus, it would appear that any effect of sensorimotor development on lexical comprehension and production could be attributed to the effect of general development rather than object permanence in particular.

10.4 Discussion

10.4.1 Object permanence and relational words

The first and primary aim of this empirical study was to investigate the claim that the acquisition and use of relational words, such as 'spin' and 'gone', might be linked to object permanence development. Tomasello and Farrar claimed that stage VI object permanence is a conceptual prerequisite for acquisition of a relational word referring to the invisible displacement of an object. The trends in comprehension scores for children with Down's Syndrome support Tomasello and Farrar's claim which suggests that the transition from stage V to stage VI should facilitate learning of an invisible displacement term. However, analysis of the data did not reveal any significant effects of object permanence development on word learning performance. Furthermore, the trends in the comprehension scores for the NDS group reveal, if anything, a general effect of object permanence development on acquisition of both visible and invisible displacement words.

Despite the lack of significant results our data do not appear to be in conflict with the findings of Tomasello and Farrar as an analysis of variance comparing the two studies demonstrated. The smaller effect sizes found in the present study may be due to the wider chronological age range used in our NDS group when compared to the control group used by Tomasello and Farrar (1986). The wider age range for our NDS children was necessary for matching to the developmental ages of the infants with DS and thus illustrates a methodological problem which is inherent in the matching procedure. The effects of a wider age range in our NDS group may have resulted in a lack of specificity with respect to developmental differences between children in the stage V and stage VI group. Furthermore, some children in the stage VI group may have been at, or beyond, this stage for some time. The problems with failing to isolate object permanence development as an independent variable may have introduced confounding developmental variables which influence general word learning and reduce effect size. Furthermore, Gopnik and Meltzoff (1986) claim that one of the mechanisms behind cognitive specificity may be the salience of conceptual transitions. Such transitions are presumably less salient over time and hence children who reached stage VI well before taking part in this study may not have had the same impetus to learn an invisible displacement word. However, while this issue may have arisen as a implicit consequence of our matching procedure, the more 'typical' results in the DS group illustrate the value of using a group with atypical developmental profile as a means of isolating particular cognitive variables. Such variables may, necessarily, be confounded in typically developing children.

The number of children reaching a criterion level of comprehension shows a similar pattern to that observed in raw comprehension scores. However, if we are to make a strong claim for stage VI object permanence as a prerequisite for learning of 'gone' then we require all children at stage V to fail to learn the word. Inspection of the number of children reaching criteria reveals a pattern which is more problematic for Tomasello and Farrar's claim. While no children in the NDS group at stage V reached criteria for comprehension of 'gone', two children with Down's Syndrome did reach the criteria for comprehension of 'gone'. This finding is counter to both Tomasello and Farrar's prerequisites claim, and Gopnik and Meltzoff's (1986) claim for cognitive specificity. However, the finding that children with Down's Syndrome may acquire conceptually laden lexical terms prior to the corresponding conceptual achievement is supported by Hassan and Messer (1995).

The pattern of spontaneous non-imitative production of relational words again reveals a similar pattern, across stage and word type, to that seen in the children's comprehension scores. However, it would appear that children with Down's Syndrome showed lower levels of production overall, albeit non significant. This result is consistent with studies showing a discrepancy between comprehension production in children with Down's Syndrome (Fowler, Gelman & Gleitman, 1994; Rondal, 1996).

Parental reports on the actual words used by the children showed similar results i.e. children at stage VI appear more likely to be producing the word 'gone 'than children at stage V. The control displacement word, 'spin', was not produced to a great extent at either stage. Given that children use the word 'gone' in a variety of different ways and not exclusively as a relational verb the evidence for a production 'gone' at stage V is, alone, inadequate evidence against a claim for conceptual prerequisites.

In summary, the trends of lexical acquisition observed in children with Down's Syndrome were not inconsistent with Tomasello and Farrar's findings but failed to reach significance. The only suggestion that children with Down's Syndrome may show an exceptional pattern is indicated by apparent comprehension of an invisible displacement word prior to attainment of stage VI. However, such a conclusion rests on the assumption that assessment of object permanence is a reliable measure of conceptual status. The results described in chapter 8 suggested no more instability in the Down's Syndrome group than in children without Down's Syndrome. However, when investigating links between conceptual and linguistic development it is clearly important for theoretical and methodological reasons to establish the relationship between our findings and potential instability in performance.

10.4.2 Relational words and stability

The second aim of this empirical study was to ascertain the extent to which stability in object permanence performance was a necessary condition for acquisition of an invisible displacement term. An analysis of comprehension scores against a measure of stability in stage VI object permanence performance was carried out to examine the possibility that instability in performance on object permanence tasks might have consequences for relational word acquisition. The results show a general trend toward higher comprehension scores with increasing stability of performance. In addition, it appears that those with stability scores of 0.33 and 0.67 (i.e. correct performance on 1/3 and 2/3 occasions respectively) may yet achieve a reasonable degree of action word comprehension. Given that the stage VI task would be difficult to pass by chance it may be that children passing on only 1/3 of occasions do have the conceptual prerequisites for relational word acquisition but simply perform unreliably on the task designed to assess their underlying competencies.

These data which relate the stability of performance to comprehension illustrate a methodological problem which may not be evident in studies using single testing sessions to ascertain developmental status. The results of this study illustrate that correct performance on one occasion may indicate sufficient conceptual understanding for lexical acquisition but such performance may not be reliable. Furthermore, despite the fact that Hassan and Messer (1995) used repeated longitudinal developmental assessments to ascertain conceptual status, it may be that the precocious emergence of lexical reference observed in children with Down's Syndrome may reflect performance instability on conceptual assessments. On a theoretical note, the evidence presented in this chapter suggests that instability in performance does not impede corresponding lexical acquisition. If there are strong conceptual prerequisites then in this case it would appear that instability is a performance problem rather than a problem of conceptual competence.

10.4.3 General relationship between sensorimotor and linguistic development

The final aim of the present study was to investigate the general claim that lexical acquisition is specifically related to sensorimotor development and to object permanence in particular. Tomasello and Farrar (1986) make the claim that object permanence is a cognitive prerequisite for acquisition of 'gone' as a relational verb but their training study did not assess children's performance on other sensorimotor scales. More general claims focus on the relationship between object permanence and lexical reference to objects

(Brown, 1983; Bloom, 1983). However, there is also evidence that lexical advances are more strongly related to means-ends performance than to object permanence (Curcio, 1978; Mundy, Seibert & Hogan, 1984; Bates, Benigni, Bretherton, Camioni, & Volterra, 1979).

The results for both DS and NDS groups indicate that, in terms of relational words, the acquisition of 'gone' is strongly related to both object permanence and means-ends performance. Furthermore, acquisition of 'spin' does not appear to be as strongly dependent on these sensorimotor measures. These results, taken together, while supporting Tomasello and Farrar's claim, suggest that the acquisition of relational words referring to invisible displacement may be related to sensorimotor development in general rather than object permanence in particular. The claim that sensorimotor development may be particularly important to the acquisition of 'gone' rather than 'spin' is illustrated by the partial correlation coefficient controlling for the 'spin' comprehension scores. Thus the acquisition of 'gone' may be dependent on sensorimotor development to a greater extent than relational words in general.

The comprehension and elicited production of novel object names also appeared to be related to the development of object permanence. Furthermore, as was the case with relational verb acquisition, production of object names followed a similar pattern to underlying comprehension. However the only significant effect in relation to object names was that children with Down's Syndrome showed lower levels of elicited production in general.

The final analysis addressed the relationship between object permanence and lexical acquisition as reported by parents who completed the MacArthur CDI. While not surprisingly measures of the children's vocabularies in terms of comprehension and production were related to sensorimotor measures, this effect was accounted for by differences in developmental age.

Thus the relationship between lexical acquisition and sensorimotor development in children with and without Down's Syndrome appears to be a general sensorimotor and developmental effect rather than a case for cognitive prerequisites. However, there is an indication that relational words referring to invisible displacement are more strongly related to object permanence than other areas of sensorimotor development. These results are therefore broadly supportive of Tomasello and Farrar's (1986) prerequisites claim.

10.4.4 General discussion: representation in linguistic and cognitive domains

Tomasello and Farrar (1986) claim that the relationship between sensorimotor development in the transition stage V to stage VI is a cognitive prerequisite for development of relational verbs labelling invisible displacements, e.g. 'gone'. The results from the present study do not preclude the existence of such a relationship in children with Down's Syndrome. Tomasello and Farrar argue that this relationship may be extended to other conceptual prerequisites in the cognitive domain. Furthermore, those who advocate theories of 'semantic bootstrapping' take the view that it is through conceptual and semantic understanding that children acquire early syntactic morphology. A number of recent accounts of early lexical acquisition claim that this period is particularly important and may exert a causal influence on later syntactic development (Tomasello, 1992; Bates et al., 1988/1991; Anisfeld, 1984). Furthermore, the acquisition of relational verbs may be significant in respect of later syntax development.

The relationship between acquisition of relational words and sensorimotor development is a particularly important issue with respect to understanding the linguistic deficit in children with Down's Syndrome. The lack of significance in the current results suggests the need for both a larger sample size and a longitudinal tracking of sensorimotor performance to isolate, in particular, transitions in object permanence development. Of particular importance to children with Down's Syndrome is the issue of stability in conceptual development. It is argued here that stability in object permanence performance does not appear to be a prerequisite for acquisition of relational terms. Furthermore, this implies that performance instability is a performance effect rather than a problem at the conceptual level[2]. In the current study, and a study by Hassan and Messer (1995), children with Down's Syndrome appear to exhibit precocious lexical reference prior to the corresponding conceptual transitions. However, these results may be due to anomalies in conceptual performance rather than linguistic anomalies. In the following chapter we investigate the development of object permanence in representational terms and consider potential anomalies within the Down's Syndrome population.

[2] Despite this finding, it may be that a motivation based performance deficit could become a conceptual deficit via a failure to reinforce newly learned skills (Wishart, 1993a)

Chapter 11

Studies 3 & 4: Object Permanence and Imitation

11.1 Introduction

The previous chapter examined the extent to which lexical and conceptual development share a common representational basis. Establishing links between measures of lexical and conceptual development presupposes that conceptual measures are both reliable and valid measures of underlying representations. The issue of *reliability* was addressed in chapter 8, in the current chapter, the *validity* of object permanence as a reflection of conceptual representation is examined.

This chapter describes two experiments, each investigating the role of imitation in the cognitive task performance of young infants with Down's Syndrome. Piaget suggested that during the sensorimotor stage, children's representational capacity was insufficient to facilitate 'representative' imitation or that involving representations. However, recent research has shown that typically developing children may be able to carry out deferred imitation tasks, which require the capacity to hold representations in memory, as young as 14 months (Meltzoff, 1985). Rast & Meltzoff (1995) have also shown that children with Down's Syndrome may have relatively strong imitation skills with respect to their developmental level and particularly with respect to object concept development. The capacity for imitation during the sensorimotor period has a number of theoretical implications for representational development in children with Down's Syndrome.

Meltzoff and Gopnik (1989) argue that in typically developing children, imitation skills, and particularly deferred imitation, are not thought to be fully developed until acquisition of stage VI of sensorimotor development. This conservative position stems from a Piagetian view of development that it is not until stage VI that children have the representational capacity required for deferred imitation (Piaget, 1951/1967). However, a growing body of research demonstrates that infants as young as 14 months can produce acts of deferred imitation. Furthermore, these children do not solve stage VI object permanence tasks until around 18 months. This evidence is counter to the Piagetian view of representation as a coherent domain general process spanning both imitation and object permanence. Meltzoff and Gopnik conclude that imitation and high level object permanence, while they both provide evidence for representation, may reflect the emergence of discrete representational systems. The existence of a unitary representational system is fundamental to Piagetian view of representational development. If it is necessary to posit a separate representational system to account for early imitation skills then a similar reassessment of representation may be required in the object permanence domain

Traditional explanations of children's failure on object permanence tasks centre upon the inadequacy of children's spatial, temporal, and object representations in the strictly Piagetian case. However, standard object permanence tasks necessarily confound the assessment of two discrete skills, or possibly representational systems. Object permanence tasks require firstly, the ability to maintain a representation of a hidden object, and secondly, the ability to plan and carry out the appropriate means of retrieval. Many researchers have shown that a child's *knowledge* of an object's location, and their *knowledge* of retrieving it, is not borne out explicitly in their retrieval *action* (e.g. Diamond, 1991; Baillargeon & DeVos, 1991). Children's failure on standard object permanence tasks can therefore be explained as a consequence of limitations in memory or attentional capacity rather than a representational failure per se (e.g. Diamond, Cruttenden & Niederman, 1994).

A wealth of research activity has been devoted to understanding children's failure on object permanence tasks and this has not been matched by accounts of children's successes (Fischer & Jennings, 1981). Fundamental to the Piagetian view of successful search is that it is driven by a representation of the hidden object. Furthermore, Piaget believed that there was a unitary representational basis underlying successful search behaviour. The validity of object permanence as a circumscribed representational system is central to Piaget's view of representational development in general. However in this chapter it is argued that children's solutions to object permanence tasks could be driven by a number of different representations which are not necessarily based on a hidden object. In particular, there is evidence to suggest that children can use cues which are associated with the hiding action rather than with a representation of the object's location.

Objects are hidden by hand in the vast majority of object permanence tasks detailed in the psychological literature. Despite this, little attention has been given to the possibility that knowledge of the hiding action, rather than object location, could provide a solution. Fischer and Jennings (1981) suggest that a child's understanding of the experimenter as an *independent agent* may provide children with a cue to an object's location. They do not imply that this agency cue is used in the absence of an object representation, but in addition to it. Essentially, Fischer and Jennings claim that children's behaviour is driven by dual representations, both an object representation, and a broadly social representation of the hiding action.

Meltzoff and Gopnik (1989) also claim that representational development is not a unitary process but comprises both 'empirical' and 'hypothetical' representations. 'Empirical representations' are representations of what was seen, whilst 'hypothetical representations' implicate the use of deductive reasoning in their construction. Empirical representations are sufficient for both deferred imitation and low-level object permanence tasks. In contrast, stage VI object permanence tasks (involving invisible displacement of objects) require the use of hypothetical representations. According to Rast and Meltzoff it is possible to draw fundamental distinctions between the demands of object permanence tasks and those of deferred imitation. Firstly, deferred imitation requires remembering another person's actions whilst object permanence requires remembering the location of an object. Secondly, high level object permanence tasks require deductions to be made of the basis of a represented action whilst for deferred imitation the representation itself is sufficient. These distinctions allow Meltzoff and Gopnik to attribute deferred imitation in 14 month olds, prior to stage VI object permanence, to the existence of empirical representations. Hypothetical representations, which emerge later, allow children to solve stage VI object permanence tasks.

Thus, the representational 'dualism' proposed by Fischer and Jennings (1981) and Meltzoff and Gopnik (1989) allows for the possibility of discontinuity between representational systems. Arguably such discontinuity may become amplified in children from atypical populations. Regardless of the particular model which we accept, both Fischer and Jennings, and Meltzoff and Gopnik, are claiming that there are distinct representational systems which may be implicated in performance on object permanence tasks. Whilst Fischer and Jennings suggest that the use of social or agency cues respects the Piagetian course of development and emerges around 18 months, in contrast, Meltzoff and Gopnik claim that the deferred imitation and its broadly social representational system is available as young as 14 months. The existence of a representational system which facilitates deferred imitation may therefore be implicated in children's performance on object permanence tasks well before the stage VI transition suggested by Fischer and Jennings. Thus it may be possible for children to use an agency cue to support performance in the face of inadequate object representations. Alternatively, children might use empirical representations, to imitate the hiding action, whilst unable to draw hypothetical deductions about the object's location.

The systems of representation proposed by Fischer and Jennings are certainly different from the systems proposed by Meltzoff and Gopnik, both in function and in development. However, there appears to be a broad agreement that some form of social-empirical representation may be distinguished from the object-hypothetical system. In this chapter, the terms 'imitative representation' and 'object representation' will be used to draw the distinction between these representational systems encoding the child's knowledge of the social and object components of the object permanence task respectively.

The existence of more than one representational system leads to the possibility of an atypical representational profile, i.e. strengths and weaknesses in representational development. Such a possibility is arguably more likely in atypical populations. Children with Down's Syndrome do have particular strengths, such as sequential visual short-term memory (Pueschel, Gallagher, Zartler & Pezullo, 1987) particularly when related to hand movements (Hodapp, Leckman, Dykens, Sparrow, & Zelinsky, 1992) which are consistent with the use of 'empirical' or imitative representations. Social and imitative strengths are also often cited as characteristic of children with Down's Syndrome (Gibbs & Thorpe, 1982; Sigman & Ungerer, 1984; Beeghly, Weiss-Perry & Cicchetti, 1990) and such findings may reflect the use of empirical representations. Rast and Meltzoff (1995), in support of this atypical representational profile, report the relatively advanced performance of children with Down's Syndrome on deferred imitation tasks relative to object permanence. In an empirical study, children with Down's Syndrome were able to carry out deferred imitation well before attainment of stage VI. The authors argue that children with Down's Syndrome have a developmental profile which is broadly advanced in the social domain, and hence in imitation.

There are a number of methodological problems with the empirical evidence supporting Rast and Meltzoff's claims (see Wishart, 1997). Most significantly, the discrepancy between deferred imitation and object permanence is also observed in typically developing children. Despite this, and in the absence of a control group, Rast and Meltzoff claim that the discrepancy is a characteristic of children with Down's Syndrome. Furthermore, the tasks used by Rast and Meltzoff to compare children's performance on object permanence and imitation domains were driven by the Piagetian view of the representational demands of the tasks. More recent views of representation and performance on object permanence tasks focus on the memory and attention limitations to children's search performance (Diamond et al., 1994; Bjork & Cummings, 1984). The comparison of deferred imitation and object permanence tasks must account for task specific factors such as these if the representational distinctions are to be isolated. These methodological issues were discussed at length in chapter 5.

Despite these methodological problems, there is some evidence for anomalies in the task performance of children with Down's Syndrome which may reflect atypical representational development. It has been argued that imitative representations may be deployed in solving object permanence tasks. The use of broadly imitative, empirical or social strategies may therefore by applied by children with Down's Syndrome to solving object permanence tasks. If the development of children with Down's Syndrome is atypical in this respect then one would expect to find corresponding anomalies within performance on object permanence tasks in addition to discrepancies between object permanence and imitation.

In support of this hypothesis, there is some evidence that children with Down's Syndrome perform in an anomalous or atypical manner when performing object permanence tasks (Morss, 1983; Wishart, 1993; Rast & Meltzoff, 1995). Specifically, differences have been observed in children's strategies for solving tasks and in the error patterns which suggest a distortion in the typical developmental progression (Wishart, 1993; Morss, 1983). However, such anomalies might be resolved if one considers the use of imitative solutions. In more general terms, the view that children with Down's Syndrome solve tasks by imitation rather than explicit knowledge of the objects location may also explain the lower levels of engagement, or 'dampening of epistemic' curiosity which some authors report (Rast & Meltzoff, 1993; Wishart & Duffy, 1990).

In summary, it appears that the validity of object permanence as a coherent representational system is threatened by the suggestion of a dual representational system. Furthermore, the atypical profile observed in children with Down's Syndrome may affect the typical balance between such dual representations and have implications for performance on cognitive tasks. Differences in search patterns have been observed in children with Down's syndrome which may reflect the use of imitative strategies in preference to strategies based on knowledge of an object's location (Wishart, 1993; Morss, 1983).

The hypothesis which forms the basis for the following empirical studies is that children with Down's Syndrome have a particular capacity for imitation which may be deployed as a means of solving cognitive tasks in other domains, such as object permanence. Furthermore the use of imitation as a strategy for solving tasks may provide an explanation for children's performance and the characteristic lack of engagement.

11.1.1 Aims

The general aim of these experiments is to investigate the representational basis of object permanence and determine the extent to which children with Down's Syndrome show a preference for one representational system. There were two specific hypotheses:

I children with Down's Syndrome will perform better on imitation tasks than children without Down's syndrome matched for object permanence skill. (imitative representations are stronger than object representations);

II children with Down's Syndrome use an imitative strategy in object search tasks and will perform poorly on object permanence tasks if imitation of the hiding action is explicitly prevented. (the use of imitative representations is implicit in the object search behaviour of children with Down's Syndrome).

11.2 Study 3: A representational comparison of object permanence and imitation

This experimental study was intended to investigate the links between children's performance on object permanence tasks and performance on a comparable imitation task. The requirement that the tasks should be comparable is intended to address problems inherent in contrasting the representational demands of object permanence and deferred imitation tasks. The tasks used by Rast and Meltzoff to compare children's performance on object permanence and imitation domains confound the representational system (OP vs. Imitation) with task specific factors such as memory and spatial components. The tasks in this experiment are designed to involve similar spatial and memory components for both imitation and object permanence and thereby isolate the representational basis for performance.

11.2.1 Method

11.2.1.1 Participants

The participants for this experiment were 18 children with Down's Syndrome (9 girls, 9 boys) and 18 children without Down's Syndrome (9 girls, 9 boys). Participants with Down's syndrome were recruited from parental support groups and local pre-school services, whilst typically developing children were recruited though local toddler groups. Developmentalages, assessed using the BSID II, and chronological ages are shown in Table 11-1.

	Mean Chronological Age (s.d.)	Mean Developmental Age (s.d.)
DS (N=18)	25.9 (9.3)	14.8 (4.5)
NDS (N=18)	12.8 (3.2)	12.8 (3.5)

Table 11-1: Chronological and developmental ages of participants

11.2.1.2 Materials

A rectangular table (dimensions 0.92m x 0.61m) with detachable legs was fitted with a concealed buzzer and switch so that the buzzer could be operated covertly. The buzzer was a 'trumpet sounder' type emitting a frequency of 450 Hz with a sound level of 75 dB at 1m from the source. Two circular wells coloured blue and green were used as loci for the hiding and imitation procedure. The wells were placed 50 cm apart on a rectangular tray. During the procedure the tray could be moved along the length of the table.

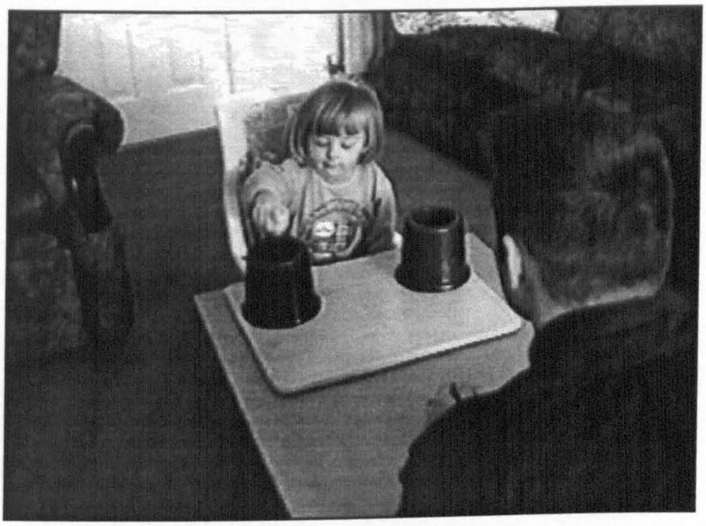


Figure 11-1: Seating of experimenter and participant during experiment

Three toy objects were used in the hiding procedure, each small enough to fit within the palm of an adult's hand; a small yellow ball, a toy car and a small toy sheep.

11.2.1.3 Procedure

Children were seen at home in the presence of their mother at a time prearranged to be suitable for both parent and child. The table was placed in the centre of the room and a video camera was placed behind the experimenter to record the activity of the child at the opposite end of the table, this seating arrangement is detailed in

Figure 11-1. Children were either seated on their parent's lap, on a chair, or on the floor. The height of the table was adjusted so that children were easily able to reach objects when placed 30 cm from the edge of the table. A Sony Handycam Hi-8 video camera was mounted on a tripod at one end of the table so as to record the child's activity. At the start of each session, the experimenter played with the child using a familiar toy for 5 minutes. Children were not permitted to play with the test materials during this familiarisation period.

Children were tested under two conditions, an imitation condition and a search condition. The order of presentation was counterbalanced between participants within groups. In the search condition an object was hidden in one of the wells in full view but out of reach of the child. In the imitation condition, without a object, the experimenter made hand movements equivalent to the hiding of an object and a buzzer was sounded for 1 second as the hand entered the well. The purpose of the buzzer was to draw attention to the 'hiding action' in common with other studies which used hand tapping for this purpose (Munakata, McClelland, Johnson & Siegler, 1994; Appel & Gratch, 1984)

After a three second delay, the tray supporting the wells was pushed to within the child's reach. Children selecting the correct well were allowed to play with the object for 5-10 seconds in the search condition or were rewarded with a contingent 1 second 'buzz' in the imitation condition. However, if children selected the incorrect well, the tray and the wells, were removed from the child's reach. Children who failed to respond after 5 seconds were offered encouragement such as 'you do it', or 'you find it', according to the condition. If, after a further 10 seconds, there was still no response the wells were removed from the child's reach.

Each condition comprised a maximum of 20 trials. For the search condition, the first 10 trials involved visible displacements whilst the second 10 trials were invisible displacements. For visible displacements the object was held in the experimenter's fingertips whilst being hidden such that the child could see the object entering the well; during invisible displacements the object was hidden in the experimenter's hand prior to being placed in the well and could therefore not be seen to enter the well. For the imitation condition, this distinction is quite clearly redundant and invisible displacements were equivalent to visible displacements. Trials were a mixture of 'switch' trials in which the hiding location was switched following successful search and 'non-switch' trials in which hiding took place at the same location following successful search. Furthermore for a switch trial in the visible condition, hiding took place at a different well, whilst in the invisible displacement condition, the wells themselves were transposed following hiding (Wishart & Bower, 1985). In terms of difficulty it is reasonable to suppose that switch trials will be more difficult than non-switch trials and that invisible displacements should be more difficult than visible displacements. Indeed, such an order is implicit in Piagetian theory. A schematic diagram of the trials in order of difficulty is shown in Table 11-2.

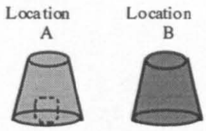
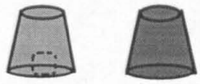
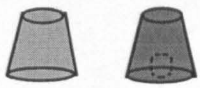
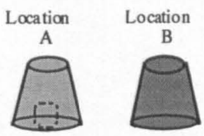
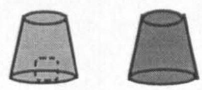
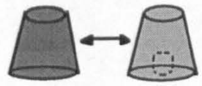
Trial		Type of Displacement (OP only)	Switch / Non-Switch (of location A-B relative to previous trial)	Stage of sensorimotor development
Trial 1		Visible	NA	IV
Trial 2		Visible	Non-Switch	IV
Trial 3		Visible	Switch	V
Trial 1		Invisible	NA	Late IV
Trial 2		Invisible	Non-Switch	Late V
Trial 3		Invisible	Switch (Wells Transposed)	VI

Table 11-2: Schematic diagram of trial types in order of difficulty

Switch trials were integrated into the procedure in the following manner according to the child's performance. If the child made two successful responses to the first location (A), hiding and imitation movements were switched to the second location (B), reverting back to location A only after two successive correct responses at B. Ten trials for which the child performed without error would therefore follow the pattern AABBAABBAA,i.e. 4 switch trials and 6 non-switch trials. For children who failed to search, or searched incorrectly, fewer than 4 switch trials would necessarily be presented. However, if the child failed to search correctly on any two successive occasions within the first 5 trials, a switch to the second location was made by default on the 6th trial (i.e. AAAAABBBBB).

This default procedure ensured that, regardless of the child's performance, at least one switch trial was included in the paradigm.

This procedure was adapted from Diamond et al. (1994) who used the two location AABBAA paradigm to combine measures of search at a single location (Stage IV) and the AAB paradigm (Stage V). Our procedure extends this paradigm to include invisible displacements (early Stage VI) and transposition of locations (late Stage VI), as used by Wishart and Bower (1995).

For both imitation and search conditions, trials were repeated if the child looked away or was distracted so as not to witness the action. For search trials in which the object no longer captured the child's attention, the object was replaced with a novel toy. For theoretical reasons this was only done during non-switch trials as the conceptual basis for a switch is that the same object can be found at a different location (Rast & Meltzoff, 1995).

During procedures of this kind, children rapidly lose interest and occasionally become distressed if they are repeatedly unsuccessful. To prevent undue distress and maintain the child's interest for the subsequent condition, testing was curtailed if the child failed on more than 5 of the first 10 trials. The number of trials presented for each condition was either 10 or 20 depending on the child's performance.

11.2.1.4 Treatment of Results

The video tapes of each session were coded by the experimenter who recorded the following information for each trial: the experimental condition (search vs. imitation), trial type (switch vs. non-switch), hiding condition (visible vs. invisible), 'hiding' location (A vs. B) and child's response location (A, B, both, or no search). A correct response was defined as a response to the same location as the hiding act. The maximum number of correct responses was 20 for both search and imitation conditions. In cases where children competed only 10 trials for a particular condition their maximum score would be

10. Analyses were carried out on both raw scores and percentage scores. The percentage scores represent the number of correct responses as a proportion of trials administered.

Children were allowed a maximum of 15 seconds to respond under both imitation and object search conditions. Given the close association between the representational and short-term memory demands of these tasks, it was felt important to include some analysis of the response times under each condition. Response times were recorded by the experimenter from the video tape of each session using a stopwatch. Times were recorded from the moment the experimenter completed a hiding action to the time the child initiated a response. These data thereby give an indication of the length of time a child would have to maintain a representation of the experimenter's action and/or the object's location.

11.2.2 Results

The object permanence performance of the each group was checked to ensure adequate similarity in performance. For the purposes of this study, the number or percentage of correct responses is regarded as a adequate measure of competence on the task. The procedure clearly deviates from the strictly defined criteria for assigning children to sensorimotor stages but maintains a similar progression in task difficulty. Children were categorised according to the stages of sensorimotor development shown in Table 11-3. This classification was used for descriptive purposes and was based on the difficult task which each child passed (e.g. invisible displacement [switch trial] ■ stage VI).

	< Stage IV	Stage IV	Stage V	Stage VI
DS	1	7	2	8
NDS	1	5	3	9

Table 11-3: Classifications of object permanence stages for DS and NDS groups

Figure 11-2 shows the number of correct responses in object permanence and imitation conditions by group. The mean number of trials administered is shown for each combination of group and condition.

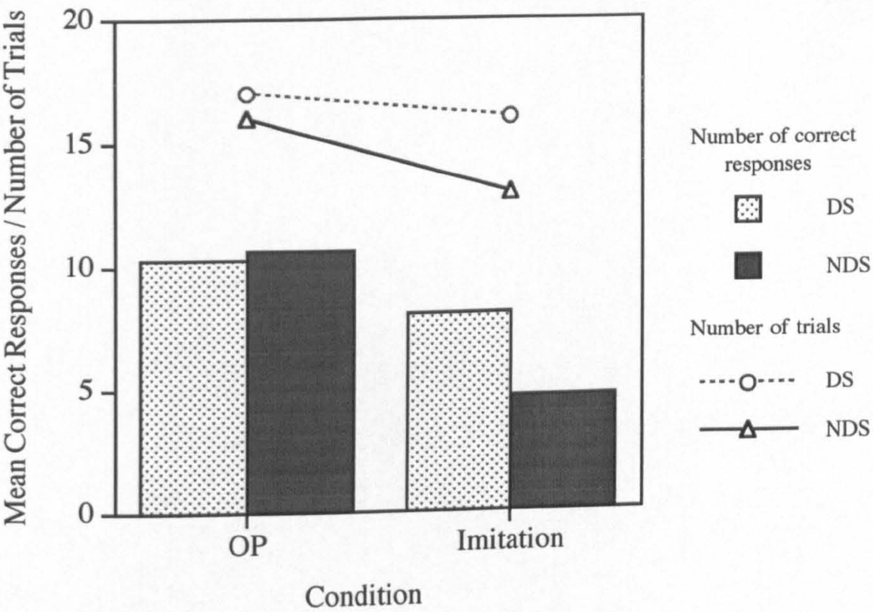


Figure 11-2: Correct responses in object permanence (OP) and imitation conditions

A three-way analysis of variance was carried out on the raw scores by condition (Imitation vs. OP), order of presentation (OP/I vs. I/OP) and by group (NDS vs. DS). The analysis revealed a significant effect of condition ($F(1,32)=22.1$, $p<0.001$) while the group effect was not significant ($F(1,32)=0.85$). The interaction group x condition was significant ($F(1,32)=4.35$, $p<0.05$). A t-test carried on total scores by group was not significant for OP score ($t(35)= 0.50$ $p>0.05$). Children with Down's Syndrome performed better on the imitation task than the children without Down's Syndrome but a t-test just failed to reach significance for imitation scores ($t(35)=1.99$, $p=0.05$). The effect of order was not significant, ($F(1,32)=0.78$, NS) nor did it interact with either condition or the condition x group interaction.

Table 11-4 shows the number of trials (either 10 or 20) completed by children in each group and in each condition. The proportion of children performing 20 trials in the OP condition is similar in both groups. However, in the imitation condition, far fewer children in the NDS group performed the full 20 trials. The reason for this was that a greater proportion of children in the NDS group failed to pass 5 trials in the first 10 for the imitation condition. Whilst this result evidently reflects poorer performance in the imitation condition it suggests that an analysis of raw scores may inflate discrepancies between the two groups.

Condition	OP		Imitation	
Group	DS	NDS	DS	NDS
10 Trials	4	6	6	13
20 Trials	14	12	12	5

Table 11-4: Number of children by number of trials performed by condition

The above analysis on raw scores was carried out both for reasons of simplicity and ease of interpretation. However, there are a number of possible anomalies in the data which were not addressed in the simple analysis. First, testing was curtailed if children failed to score more that 50% on the first ten trials. The different number of trials by condition and group could therefore be responsible for the significant effects reported. Second, the number of switch trials administered was also dependent on performance. A switch trial necessitated correct performance at one location on two successive trials. Therefore, children responding incorrectly would necessarily be presented with fewer switch trials. A third potential problem with our data is that the children, whilst matched for developmental age, were not perfectly matched for object permanence. The results presented above could reflect group differences in object permanence development.

These issues were each addressed in a subsequent analysis. The raw scores for switch and non-switch trials were separately converted to proportions of trials presented. Figure 11-3 shows the proportion of correct responses as a percentage of trials administered under each condition. The mean of these proportional measures was subsequently used as a dependent variable in an analysis of variance. The stage of object permanence was included as a covariate in the analysis to account for any systematic differences in object permanence level.

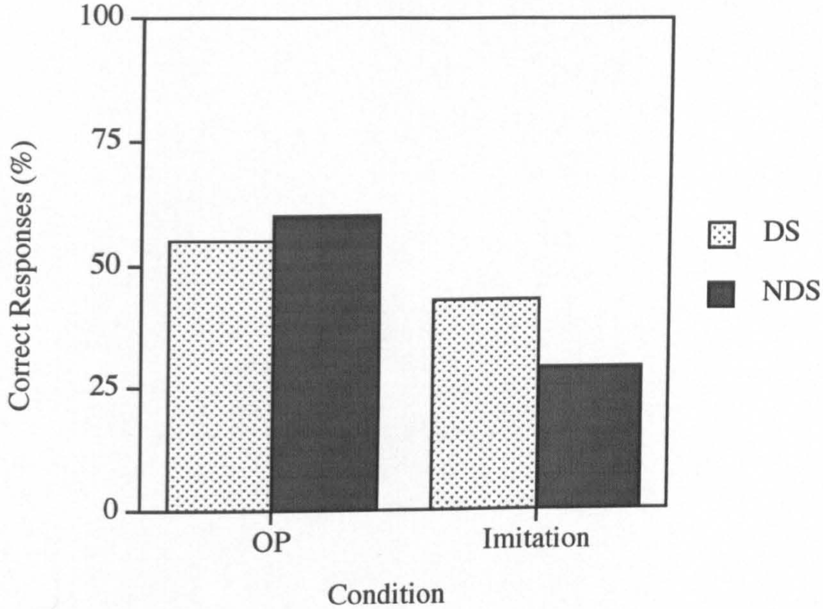


Figure 11-3: OP and imitation scores (correct responses as a proportion of trials administered) by group (DS and NDS)

A three way analysis of variance (condition x group x order) was carried out on the proportion of correct responses as detailed above. The object permanence stage was included as a covariate in the analysis. This analysis, shown in Table 11-5 and Table 11-6, reflects a similar pattern to the simple analysis previously described.

	SS	DF	MS	F	Sig. of F
Within + Residual	1.10	31	0.04		
Regression	2.26	1	2.26	63.95	0.001
Group	0.08	1	0.08	2.16	0.152
Order	0.00	1	0.00	0.06	0.805
Group x Order	0.06	1	0.06	1.60	0.215

Table 11-5: Analysis of variance (between-subjects effects)

	SS	DF	MS	F	Sig. of F
Within + Residual	0.98	32	0.03		
OP/Imitation	0.80	1	0.80	25.99	0.001
Group x OP/Imitation	0.16	1	0.16	5.18	0.03
Order x OP/Imitation	0.00	1	0.00	0.06	0.808
Group x Order x OP/Imitation	0.00	1	0.00	0.08	0.773

Table 11-6: Analysis of variance (within-subjects effects)

The results of these two analyses confirm that children in the DS group performed better in the imitation condition than children in the NDS group. The two groups performed similarly well in the object permanence condition.

Correlations between total scores on OP and imitation were calculated for both groups and are shown in Table 11-7. Children in the DS group showed a strong and significant correlation between OP and imitation scores. In contrast, the correlations between OP and imitation scores for the NDS group were both weak and non significant. Once again it is possible that the different number of trials presented across conditions and groups might have affected the correlation coefficients. Partial correlations which control for the number of trials presented in each condition are therefore also shown in Table 11-7. Surprisingly, these partial correlations are weaker in the NDS group suggesting that failures by default did not lead to an artificially low correlation in this case.

	DS (N=18)	NDS (N=18)
Correlation (Imitation * OP Scores)	0.85***	0.32
Partial Correlation (by Number of missing trials)	0.85***	0.10

*Table 11-7: Correlations between OP and imitation scores DS & NDS groups (***p<0.001)*

The strong correlation coefficients in the DS group therefore indicate a close relationship between performance on the object permanence and imitation tasks. Furthermore, this difference does not appear to be due to differences is the number of trials administered.

11.2.2.1 Error rates and response times

The aim of this study was to investigate children's performance on object permanence and imitation tasks. Furthermore, the design of the study was intended to maximise the contrast in representational terms and minimise any task specific cognitive demands. Limitations in memory and inhibition of prepotent responses are thought to be fundamental to performance on object permanence tasks (Diamond et al., 1994; Bjork & Cummings, 1984). It was therefore considered important to investigate the timing and error types which characterise children's responses across the experimental conditions. The purpose of the following analyses was to establish the degree to which discrepancies in performance are representational as opposed to more general cognitive limitations.

The first analysis focuses on mean response times in each condition. As discussed in the method, a three second minimum response time was ensured by delaying presentation of the materials to the child. Any additional response time is therefore dependent on the child. The mean response times (by child) are shown in Table 11-8 according to response type (correct vs. incorrect) and group (DS vs. NDS). These times include the 3 second delay imposed explicitly in the procedure.

Condition	OP		Imitation	
Group	DS	NDS	DS	NDS
Correct	4.13 (1.36)	4.99 (1.78)	4.21 (0.90)	5.10 (2.20)
Incorrect	5.17 (2.15)	5.18 (1.74)	4.54 (1.55)	5.03 (2.00)

Table 11-8: Mean response times for correct and incorrect responses by condition and group (s.d.)

A three-way analysis of variance (group x response type x condition) was carried out on response times. It was necessary to exclude 11 cases where responses timings were not available across all conditions (due to non-correct responses). These excluded cases were children who were 100% successful or unsuccessful within a particular condition or cases where failures were entirely characterised by a failure to respond. The resulting analysis carried out on 25 cases revealed non significant effects for group ($F(1,23)=0.07$), condition (F $1,23)=0.38$), and response type ($F(1,23)=1.83$). The interactions were non significant in all cases.

These results suggest that incorrect responses in either condition or group may not be attributed to the length of response time and the consequent cognitive limitations which such anomalies might suggest.

Error types were subsequently categorised according to the response type; either choosing the incorrect well, both wells simultaneously, or failing to respond within a 15 second time limit. The mean proportion of error types by group and condition is shown in Table 11-9. Two children who made no errors within a particular condition were excluded from this analysis. From the table, it is clear that the error patterns differ between groups. One of the most striking anomalies is that children in the DS group show a greater proportion of incorrect responses directed at both wells.

Condition	OP		Imitation	
Group	DS	NDS	DS	NDS
Incorrect Well	47.3 (34.1)	61.2 (35.5)	37.9 (30.89)	38.8 (34.6)
Both Wells	23.4 (29.3)	5.3 (12.6)	27.8 (33.3)	7.8 (18.6)
No Response	29.3 (34.8)	33.5 (34.7)	34.3 (30.6)	53.4 (36.4)

Table 11-9: Percentage error rates by error type

A three way analysis of variance (error type x condition x group) was carried out on the proportion of error types for 69 cases. Only within subject effects are meaningful when comparing proportions in this way. The effect of error type was significant ($F(2,130)=11.4$, $p<0.001$) as was the interaction of group x error type ($F(2,130)=3.26$ $p<0.05$). The interactions of condition x error type ($F(2,130)=2.47$) and the three way interaction group x condition x error type ($F(2,130)=0.58$) were not significant.

These results suggest that the pattern of errors is dependent on the group variable. Bonferoni adjusted t-tests were carried between groups for each response type. T-tests for 'incorrect well' and 'no response' were not significant ($t(1,67)=0.85$; $t(1,67)=0.1$). However, the t-test carried out on the proportion of 'both well' error was significant ($t(1,67)=2.17$, $p<0.05$), reflecting a greater proportion of this error type in the DS group.

The lack of an interaction between error type and condition, and the non-significant three way interaction suggest that differences between the conditions cannot be attributed to anomalous errors. The two analyses performed on children's error rates suggest that the effects reported in our previous analyses are not caused by anomalous performance factors reflected in error rates.

11.2.3 Discussion

This study addressed the issue of a dissociation between imitative and object representations in children with Down's Syndrome. Rast and Meltzoff's comparison of deferred imitation and standard search tasks failed to control for task specific information processing demands. Performance on deferred imitation tasks prior to performance on a stage VI search task is certainly evidence against Piaget's view of representational development. However, as with a number of Piagetian tasks, manipulation of the information processing requirements might result in improved performance in younger children. Rast and Meltzoff's data could therefore be dismissed as an artefact of the memory and information processing demands of the different tasks. If one is to claim that discrete representational systems are implicated in imitation and object permanence tasks then the information processing demands of the particular tasks must be controlled for.

The results of the present study support the general findings of Rast and Meltzoff (1995). Children with Down's Syndrome appear to perform better on an imitation task than on object permanence tasks when spatial, motor and memory demands are comparable. Rast and Meltzoff's study failed to include a control group, and could not therefore make specific claims about children with Down's Syndrome but only about a general capacity for deferred imitation during the sensorimotor period. The results of the present study also demonstrate that children with Down's syndrome appear to have a relative strength in imitation tasks when compared to children without Down's Syndrome matched for object permanence.

In representational terms, the capacity for imitation may implicate a discrete representational system from that typically involved in object permanence tasks. The relative strength of children with Down's Syndrome on the imitation task may therefore reflect a capacity for imitative representations in excess of object representations. In the introduction to this chapter it was suggested that a strategic use of imitation may be of service in solving object permanence tasks. The current findings in relation to imitation suggest that children with Down's Syndrome can, in contrast to typically developing children, 'search' when no object is hidden. High correlations between imitation and object permanence tasks suggests a possible link between these tasks in children with Down's Syndrome. Furthermore, the analysis of error types made by children with Down's Syndrome suggests the use of an atypical strategy in both imitation and object permanence tasks. This atypical strategy may reflect the predominant use of imitative representations in both search and imitation.

In contrast, the performance of typically developing children on object permanence tasks does not implicate imitation. Object permanence and imitation tasks were only weakly correlated in the NDS sample. Furthermore the errors made by typically developing children on object permanence tasks suggests conformity to the standard representational account of failure (Morss, 1983). Other research also suggests that typically developing children do not search on a purely imitative basis when no object is hidden (Appel & Gratch, 1984). Bertenthal and Fischer (1983) discount such a possibility as 'obviously' untenable - 'the child would not search under, or behind the screens if a hidden object was not involved in the procedure'.

The tendency for children with Down's syndrome to respond imitatively when no object is hidden therefore has a number of implications for performance on the standard object permanence task. The corollary of children's imitative strength could be that children with Down's Syndrome are not especially motivated by object retrieval or 'epistemic curiosity'. Furthermore, the representational components of imitation with respect to spatial and memory requirements could facilitate solution of object permanence tasks in the absence of explicit knowledge of object location. The next experiment sets out to investigate the possibility that correct solutions to object permanence in children with Down's Syndrome might rely on imitative representations rather than object representations.

11.3 Study 4: The use of imitative representations in object permanence tasks

11.3.1 Introduction

This experiment was designed to ascertain how children with Down's Syndrome would perform on an object permanence task which explicitly prevents imitation as compared to a standard OP task.

In our 'non-standard' version of object permanence tasks the means of retrieval differs from means of hiding. Objects are hidden by dropping them through holes in the base of plastic cups. The holes are too small to allow retrieval of the objects by reversing this procedure. The children are required to use a lever in order to indirectly retrieve the object from beneath a cup. The lever is used only by the child following an initial demonstration by the experimenter. In such a task, the child cannot use empirical strategies for retrieval as the means of retrieval differs substantial from the means of hiding. It is hoped that this procedure will allow us to investigate different strands of development in terms of both object representation and search behaviour.

11.3.2 Method

11.3.2.1 Participants

The participants for this experiment were 18 children with Down's Syndrome (8 girls, 10 boys) and 18 children without Down's Syndrome (6 girls, 12 boys). Participants with Down's Syndrome were recruited from parental support groups and local pre-school services, whilst typically developing children were recruited though local toddler groups. Some children had taken part in previous studies, see chapter 7.

Developmentalages, assessed using the BSID II, and chronological ages are shown in Table 11-10.

	Mean Chronological Age (s.d.)	Mean Developmental Age (s.d.)
DS (N=18)	23.0 (8.0)	13.5 (4.5)
NDS (N=18)	13.0 (4.0)	12.9 (4.5)

Table 11-10: Chronological and developmental ages of participants

11.3.2.2 Materials

Three cup and lever devices were constructed as shown in Figure 11-4. The cups were in three bright colours, red, yellow and blue, each with white spots. The apparatus was designed such that a small ball could be dropped through the transparent tubing into the cup but could only be retrieved by use of the lever. Once the lever was pressed by the child, the ball would roll from the bottom of the cup along the base of the apparatus and could then easily be retrieved. These cup and lever devices will hitherto be referred to as 'levers'.

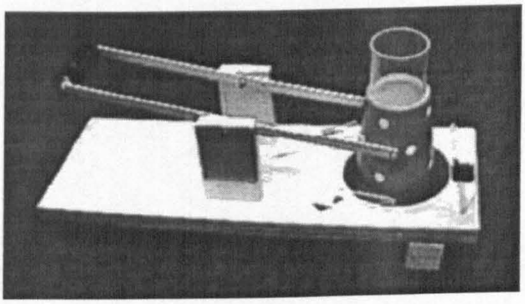


Figure 11-4: Cup and lever assembly as used in study 4

A second set of free-standing cups and tubes, without levers, were produced in order to control for the effects of the means of hiding on retrieval success.

The toy objects were used in the standard tasks each small enough to fit within the palm of an adult's hand; three coloured foam balls, a toy car and a small toy sheep.

11.3.2.3 Procedure

Children were seen at home in the presence of their mother at a time prearranged to be suitable for both parent and child. Children were either seated on their parent's lap or on the floor directly opposite the experimenter. This seating arrangement is detailed in Figure 11-5. At the start of each session, the experimenter would play with the child using a familiar toy for a maximum of 5 minutes. Following this period, children were presented with each of the test materials; a coloured cloth cover, a 'cup', and the lever apparatus. When the lever apparatus was introduced, a small toy was attached to the top of the 'cup' and the experimenter modelled the action of pressing the lever, 'making the bunny jump'. Children were then encouraged to press the lever up to three times, 'you make the bunny jump'. All children were able to do this.

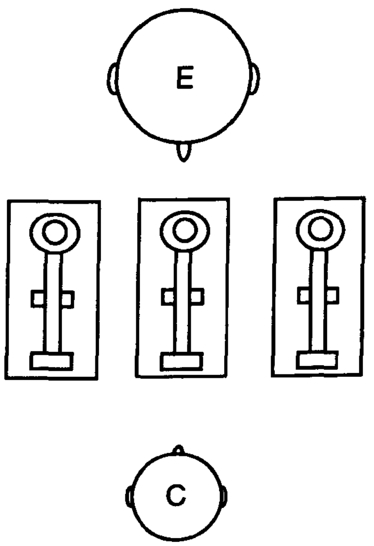


Figure 11-5: Seating arrangement for study 4 (experimenter (E), child (C), and three lever devices shown)

Children were tested under three conditions; the standard condition (*standard*), the lever condition (*lever*) and the cup condition (*cup*). Children were tested under all conditions within a single testing session lasting up to 40 minutes. The three conditions were presented in an order which was counterbalanced between participants.

The standard testing condition was adapted from the Uzgiris and Hunt (1975) object permanence scale as used in study 2. Items 4, 8, 10, 13, 14, and 15 were selected from the standard scale and details of these items are given in Appendix B.

The hiding tasks for the lever condition were intended to match the demands of the standard scale with the additional means end requirements of pressing the lever to effect retrieval of the object. The scale was the same as in the standard condition with levers used in place of covers. In order to facilitate invisible displacements, the transparent tubes were covered with small opaque funnels so that the object could be placed into the cups invisibly after being concealed in the experimenter's hand. The testing procedure for the 'cup' condition was identical to that of the lever condition.

For each condition, an object was hidden according to the protocol and children were allowed to search. Four trials were presented for each scale item in each of the three conditions. Children searching at the correct location were allowed to play with the found object for 5 to 10 seconds.

For all conditions, trials were repeated if the child looked away or was distracted so as not to witness the action. For search trials in which the object no longer captured the child's attention, the object was replaced with a novel toy. For the lever condition a number of different coloured balls were used to introduce novelty. For theoretical reasons the hidden object was only changed during non-switch trials (cf. Rast & Meltzoff, 1995).

11.3.3 Results

The groups of children were classified by sensorimotor stage on the basis of performance on the standard object permanence tasks. Once again this classification is used for descriptive purposes only. These classifications are shown in Table 11-11 and are based on 3/4 correct trials at each level of the standard tasks (see Appendix B). The groups are not perfectly matched in terms of object permanence level, but if anything the children in the DS group are more advanced. However, the current hypothesis is that children with Down's Syndrome would perform worse than the NDS group when imitation is prevented. The fact that children with Down's Syndrome may be relatively advanced in object permanence is conservative with respect to this hypothesised difference.

	< Stage IV	Stage IV	Stage V	Stage VI
DS	1	2	3	12
NDS	0	2	6	9

Table 11-11: Classification of participants by group and by object permanence stage

Given the additional means-ends demands of the lever condition it is important to establish that this fact alone could not account for performance differences between conditions. All children were required during pre-testing to operate the lever successfully. During testing on the lever condition, 16/18 children in the DS group and 17/18 children in the NDS group operated the lever for the first item on the scale on at least two trials. Thus it is clear that the majority of children in both groups are able to effect a means-ends solution on this task.

The percentage of correct retrievals in each group and for each condition is shown in Figure 11-6. Given that the number of trials is the same in each condition, performance in expressed as a percentage of trials administered. Whilst children in the DS group are relatively advanced in terms of the standard and cup versions of the object permanence scale, they perform worse than the NDS group in the lever condition. The lever condition prevents solutions by imitation and this result, if significant, supports the current hypothesis.

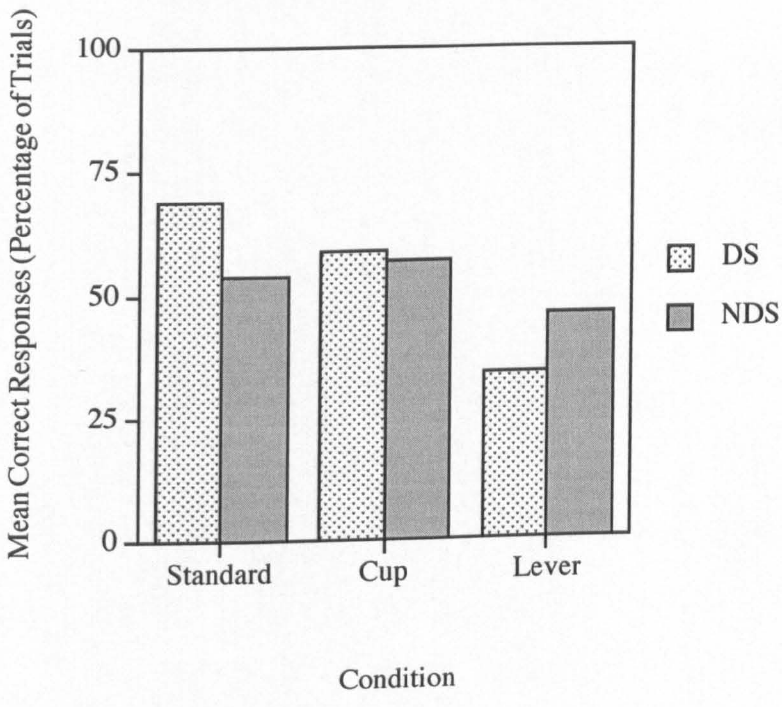


Figure 11-6: Correct search responses by condition and by group.

A three way analysis of variance (group x condition x order) was carried out on the number of correct responses under each of the three conditions, for the two groups (DS and NDS). Order of presentation was included as a factor in the analysis and developmental age was included as a covariate. The effect of group was not significant ($F(1,23)=0.02$). The effect of condition was significant ($F(2,48)=13.18$, $p<0.001$) as was the interaction between condition and group ($F(2, 48)=4.87$, $p<0.05$). There were no significant effects involving order of presentation of the conditions. Dunnett's test was used for pairwise comparisons between experimental, lever and cup conditions, and the standard condition as a control (Dunnett, 1964). For children with Down's Syndrome there were significantly fewer correct responses in the lever condition than in the control condition (Dunnett's t $X_{lever} - X_{Standard} = 6.22$, $p<0.05$). There was no significant difference in the number of correct responses in the two control conditions ($X_{cups} - X_{Standard} = 1.78$, NS). For the NDS group the number of correct responses in either of the experimental conditions was not significantly different from the standard condition ($X_{lever} - X_{Standard} = 1.44$, NS, $X_{cups} - X_{Standard} = -0.61$, NS).

Table 11-12 shows the correlation coefficients between scores on the standard OP task and on the lever task. Only the correlation for the NDS group, of 0.77, reached significance.

	DS	NDS
Correlation	0.40	0.77**

*Table 11-12: Correlations between scores on lever condition and standard object permanence scale(** p<0.001)*

In the previous experiment, it was argued that a high correlation between scores in each condition may indicate use of a similar strategy in both. In the current experiment the hypothesis suggests that children in the NDS group are using the same representational basis to effect a solution in all conditions. In contrast, children in the DS group are hypothesised to use an imitative strategy on the standard task which is prevented in the lever task.

11.3.4 Discussion

In reference to our hypothesis it appears that children with Down's Syndrome perform significantly worse on an object permanence task which explicitly prevents them solving by imitation. In contrast, children with Down's Syndrome perform at a similar level to children in the NDS group on a standard object permanence task. This pattern of results suggests that the strategy which children with Down's Syndrome use to effect a solution on the standard object permanence scale does not lead to a solution in the lever task.

A strong relationship between performance on the standard and lever versions of the object permanence tasks would suggest a close correspondence between the demands of the tasks, representational and otherwise. Performance on the standard and the lever tasks is highly correlated in the NDS group but not in the DS group. This pattern of results may reflect the fact that children with Down's Syndrome approach the object permanence task with an imitative strategy which fails to provide a solution to the lever task.

In representational terms it is argued that children with Down's Syndrome solve object permanence tasks using imitative representations which reproduce the hiding action of the experimenter. Imitation of hiding actions results in successful retrieval in the standard task but not in the lever task. In contrast, children in the NDS group may use object representations to determine their search behaviour. A representation of the object's location drives a mean-ends solution in both conditions. Thus children in the NDS group would appear to be constructing an appropriate mean-ends solution on the basis of the object's location whilst children with Down's Syndrome simply reproduce the hiding action.

In order to claim that the prevention of imitation reduces performance on the lever task we must first discount the possibility that the lever task introduces extraneous cognitive demands. One possibility is that the lever task increases the means-ends demands of the task and it is these demands which affect the performance of children with Down's

Syndrome. However, the vast majority of children in both groups were able to perform the single location lever task and would therefore appear capable of a mean-ends solution. The means-ends demand would therefore seem unlikely to be the critical factor responsible for a deterioration in performance on the lever task. The failure of children with Down's Syndrome is arguably therefore a failure to use an appropriate retrieval strategy which is within their repertoire.

What remains to be explained is the reason for children with Down's Syndrome using an imitative rather than an object based strategy. There are a number of potential explanations for children's recourse to imitation. Imitative responses may place fewer demands on limited cognitive resources in children with Down's Syndrome. Alternatively, imitative representations may be stronger in children with Down's Syndrome than in typically developing children. In either case, it appears that the use of imitative strategies may be prevalent in the performance of children with Down's Syndrome on object permanence tasks.

11.4 General Discussion

The first study in this chapter, study 3, demonstrated that children with Down's Syndrome have a relative strength in imitative performance relative to performance children without Down's Syndrome matched on a standard object permanence task. In addition, children with Down's Syndrome also appear to spontaneously imitate hand movements in a task designed to mimic the spatial and memory demands of an object permanence task (cf. Appel & Gratch, 1984). The second study in this chapter, study four, demonstrated that children with Down's Syndrome may solve standard object permanence tasks by imitation and the prevention of imitation results in a corresponding decrement in performance.

It is suggested therefore that imitation is a stronger feature of the cognitive style of infants with Down's Syndrome than of typically developing infants. However, it is vital to retain a distinction between explanations of competence and those of motivation. An alternative view of the pattern of results presented in this chapter is that children with Down's Syndrome are fulfilling different motivational constraints which prefer a different set of solutions to tasks. Therefore, children with Down's Syndrome may be motivated to imitate whilst typically developing children are not. Thus it would be premature to conclude that children with Down's Syndrome cannot solve tasks other than by imitation, instead they may merely prefer an imitative solution.

If imitation does prove to be a relative strength for children with Down's Syndrome it may change children's performance on a number of tasks. How could a preference for imitation arise? As was argued above, an imitative solution may be less cognitively taxing and therefore represent a more efficient way of deploying limited cognitive capacity. Alternatively, in representational terms, the salience of the imitative representation in the representational repertoire of children with Down's Syndrome may be forced to compete with the explicit representation of the object's location.

Munakata et al. (1994) argue that representations may be viewed as gradualistic and stronger representations may drive more cognitively demanding solutions in terms of means-ends behaviour. If we view this proposal in the context of the present results it could be argued that the imitative representations are sufficiently strong to drive a retrieval action whilst object representations are correspondingly insufficient. Thus, when then object permanence demands are increased, the object representation is correspondingly weakened and unable to effect a retrieval. In such cases children with Down's Syndrome may override object representations with imitative representations.

In a standard object permanence task, hand movements provide cues to the object's location, and in this case, both imitative and object-oriented solutions coincide. In our modified lever task, imitative and object-oriented solutions may compete in driving mutually exclusive actions. In such a situation children with Down's Syndrome perform especially poorly. Perhaps the existence of competition rather than the explicit absence of object representation may be the cause of failure. It may be important to establish how children with Down's syndrome develop explicit representations of objects as proposed by Piaget. One way of ascertaining the representational status of the child with respect to object permanence would be to assess object permanence in the absence of hand movement cues which provide imitative solutions. Such tasks are relatively common, for example those used by Butterworth (1975) and Harris (1974), or dishabituation tasks such as those used by Spelke (1990) and Baillargeon and DeVos (1991).

Irrespective of the nature of object representation in children with Down's Syndrome, the results of these studies suggest a preference for imitation in solving tasks. The results are also consistent with reports of aberrant error patterns and task difficulty which may also be explained in terms of a problem solving approach driven by imitation. Wishart and Duffy (1990) report reversals in the standard ordinal difficulty scale and Morss (1983) suggests that search errors in children with Down's syndrome are atypical. The use of the cues provided by hand movements may explain why children with Down's Syndrome show differences between modifications of object permanence tasks which have no effect on the performance of typically developing children. In particular, children with Down's Syndrome appear to distinguish between hidings involving hand movements and those which do not. Hidings involving hand movements are not necessarily easier for children with Down's Syndrome (e.g. Wishart, 1993) but clearly involve a different set of task demands from those hidings which are not 'cued' by hand movements. The tasks used by Wishart (1993) are not directly comparable in terms of hand movement cues but illustrate the existence of additional influences on task performance in the Down's Syndrome population. The data from our first study confirms the existence of an atypical error pattern in children with Down's Syndrome. Furthermore, the suggestion that performance on object permanence tasks may not be driven exclusively by the representation of a hidden object may explain lower levels of engagement in such tasks (Wishart & Duffy, 1990; Morss, 1983; Rast & Meltzoff, 1995).

In summary, the current studies suggest that tasks involving imitation appear to be easier for children with Down's Syndrome than tasks which demand explicit representations of an object's location. Children with Down's Syndrome may therefore be using a qualitatively different strategy to achieve success on a standard object permanence task. This finding casts doubt on assessment practices which use traditional object permanence tasks as a reflection of object concept development. The evidence for imitative representations in addition to object representations is contrary to the unitary view of representational development as proposed by Piaget. Furthermore the suggestion of representational dualism within the object permanence domain support the theoretical views espoused by Fischer and Jennings (1981) and Meltzoff and Gopnik (1989) in relation to representational development. Imitation may represent a particular representational strength for children with Down's Syndrome which may be applicable to a number of other cognitive domains. Before considering the wider developmental implications and mechanisms behind this imitative strength it will be necessary to establish the general use of imitation in relation to other domains. The particular motivational, attentional constraints which prevail in object permanence tasks may not allow generalisations to children's spontaneous representational activity. In the following chapter, the issue of imitative representation is addressed in relation to the general, spontaneous representational acts implicated in symbolic play.

Chapter 12

Study 5: Symbolic Play and Imitation in Children with Down's Syndrome

12.1 Introduction

The previous chapter examined the role of imitative representations in performance on object permanence tasks. Children with Down's Syndrome in contrast to typically developing children, appear to use imitative representations in performing such tasks. At the end of the previous chapter it was concluded that the development and use of imitative representations may be a relative strength in children with Down's Syndrome. In order to substantiate this claim it is necessary to demonstrate that the use of imitative representations characterises performance across a broad range of tasks. The current chapter addresses the use of imitative representations in play. The contrast between object permanence tasks and play is particularly striking in terms of task and motivational demands and is therefore a crucial area in which to demonstrate the generalisation of our representational claim. Furthermore, the contrast between play and imitation as distinct developmental processes, introduced in chapters 5 and 6, is particularly informative with respect to representational development in children with Down's Syndrome.

Play and imitation fulfil complementary developmental roles and broadly characterise the Piagetian processes of accommodation and assimilation. An adequate balance between these processes is central to Piagetian view of development. Whether we characterise the representational duality as that of 'empirical - hypothetical', as Meltzoff and Gopnik (1989) suggest, or between assimilation and accommodation according to Piaget, there may be a discrepancy between these representational processes in children with Down's Syndrome. The relative strength of the 'imitative' representational form, if confirmed in children with Down's Syndrome, should be evident in children's play as in all other domains. The present study investigates the role of imitative representations in the pretend play acts of children with Down's Syndrome.

A number of studies report that children with Down's Syndrome develop symbolic play in the same sequential manner as that observed in typically developing children (Krakow & Kopp, 1983; Beeghly, Weiss-Perry & Cicchetti, 1990). Furthermore, the proportion of time spent engaged in spontaneous symbolic play appears to be similar in children with and without Down's Syndrome. However, close examination of the quality of play acts in children with Down's Syndrome reveals a number of differences in play quality. For example, Krakow and Kopp (1983) characterise the play of children with Down's Syndrome as 'rigid, stereotypical and repetitive'. Beeghly et al. (1990) found evidence that children with Down's Syndrome produce fewer object substitutions, or symbolic acts, than typically developing children. A number of other studies also suggest an increased tendency towards repetition of symbolic acts without elaboration (Riguet, Taylor, Benaroya, & Klein 1981; Beeghly et al., 1990).

Explanations of the differing quality of play focus on differences in both attention and motivation in children with Down's Syndrome. Krakow and Kopp suggest that children with Down's Syndrome may not be aware of, or are unable to take advantage of, the object and social resources available. According to Krakow and Kopp, such differences reflect excessive focus on one stimulus, either social or toy, during play. There is substantial evidence to suggest that children may selectively attend to social stimuli in preference to toys during dyadic play (Gunn, Berry & Andrews, 1982; Berger & Cunningham, 1981; Kasari, Mundy, Yirmiya & Sigman, 1990; Landry & Chapieski, 1990) although this bias appears to depend on the relative salience of object and social stimuli (Ruskin, Mundy, Kasari & Sigman, 1994).

Many explanations of the development of children with Down's Syndrome appeal to reduced motivation as a cause for deficits. Symbolic play is no exception in this respect and a number of studies show a reduction in 'mastery motivation' in children with Down's Syndrome (Gunn, 1982; Gunn et al. 1981; Berry, Gunn & Andrews, 1984;

Ruskin et al., 1994). The lower motivation may therefore explain the lack of flexible and elaborate symbolic play in spontaneous situations.

Pretend play is considered to be an important index of children's cognitive development and underlying representational capacity (Jarrold, Boucher & Smith, 1991; Fein, 1981) There is a strong case for differences in motivation and attention in children with Down's Syndrome which may in turn lead to differences in the quality of symbolic play. However, it is equally possible that differences in representational status are primarily responsible for differences in play quality with differences in motivation and attention reflecting these representational discrepancies. The use of imitative representations in object permanence tasks was linked to motivational and performance anomalies in the context of object permanence tasks. In terms of play, a tendency to rely on imitative representations may also reduce the intrinsic motivation to play. Karmiloff-Smith (1992/1995) claims the reverse causal link between representation and motivation citing the importance of achieving behavioural mastery in establishing an explicit representational basis for action. Irrespective of the causal connection between representational, motivational and attention based accounts of performance, it is clear that such accounts are not mutually exclusive. However, the current chapter will focus on the representational account of pretend play and associated discrepancies between children with Down's Syndrome and typically developing children.

The studies in chapter 11 demonstrated that a weakness in object representations could be supplemented by imitation thus implying a duality in underlying representational components. In this chapter it is argued that symbolic play reflects a similar duality in representational terms, a capacity to acquire representations through imitation and a complementary capacity to deploy representations in play. Just as children's search behaviour may be distinguished when driven by object or imitative representations, in symbolic play, a distinction may be drawn between imitative and 'play representations'. The term 'play representation' is used here to refer to the knowledge which the child maps onto objects and events during symbolic play. The term is used in preference to symbolic representations[1] which have distinct theoretical connotations in relation to play. The distinction between imitative and play representations will now be discussed.

Piaget argued that imitation and play during the sensorimotor period characterise opposing processes of accommodation and assimilation respectively (Piaget, 1951/1967). Accommodation, and imitation, are processes by which children incorporate new information into their representational schemes. In contrast, assimilation, and play, represent the application of existing schemes in new contexts and to novel objects. Thus, during the sensorimotor period, imitation represents the input to the child's schema whilst play represents the output generated by internal schema. While imitation necessitates some output on the part of the child, Piaget argued that this output is not representational during the sensorimotor stage. With the onset of representational thought, the distinction between play and imitation becomes increasingly complex. At this stage, both imitation and play comprise representational output. However, Piaget argued that the distinction between the 'pure forms' of imitation and play remains. Piaget refers to the imitation process as heavily context bound and dependent on the use of familiar objects. The process of play, in contrast expresses representation in new situations and adopts novel objects. Here, play and imitation are referred to in their extreme, pure forms. Piaget suggested that 'play', as a typical behaviour, is characterised by complementary processes of assimilation, pure play, and accommodation, pure imitation.

Thus the distinction which is drawn in this chapter between play representation and imitative representation may be seen as corresponding to the Piagetian processes of assimilation and accommodation. Children's play acts may therefore be characterised by a balance of both imitative and play representations. Contemporary views of play development draw a clear distinction between symbolic and functional play. Developmental trends in play result in the increasing tendency to play symbolically and a corresponding reduction in functional play. According to Leslie (1987), symbolic play reflects a reduction in the reliance on real or lifelike objects in play. Children are therefore

[1] Symbolic play is often regarded as 'meta-representational' (e.g. Perner, 1991)

deemed to be playing 'symbolically' when using one object to represent another. Huttenlocher and Higgins (1978) define symbolic play in terms of a capacity for play which could not be learned or copied directly from adults. In terms of imitative and play representations, the increasing use of object substitutions and reduced reliance on adult models may reflect a developmental shift in play representation towards symbolic play representations, and away from functional representations. Furthermore, there may be a corresponding decline in imitative representations akin to the decline in empirical representations proposed by Meltzoff and Gopnik (1989). While the claim for representational duality in play may be controversial, this distinction allows us to discuss potential anomalies in representational development.

It is thus argued that pretend play under normal circumstances impinges on two representational systems, a stored representation of the real action which is essentially imitative, and a more abstract representation of the meaning of the play act, the play representation. The child's response to an adult model thus involves bringing together these two representations. If for example, a child is seen to brush dolly's teeth, she has brought together a representation of an event they have witnessed, essentially imitative, and used a play representation to generate a meaningful reconstruction of the event in a novel context. The relative contribution of imitative representations thereby reflects the child's faithful adherence to the adult model. Conversely the contribution of play representation frees the child from a context bound reproduction of the adult's model to express abstract knowledge of the act with new materials and in new contexts.

In the previous chapter, it was argued that children with Down's Syndrome have a tendency to rely on imitative representations. When extended to play the use of imitative representations would suggest a number of anomalies in play quality. Consistent with reliance on imitation, there are a number of anomalies in the play of children with Down's Syndrome such as rigidity and repetition (Krakow & Kopp, 1983; Beeghly, Weiss-Perry & Cicchetti, 1990). However, in order to demonstrate empirically the relative strength of imitative as opposed to play representations we need to establish a framework whereby the use of such representations may be discriminated.

In the case of functional play, one would expect the two representational systems to converge and support each other in some way. As Piaget argues, albeit with different terminology, intelligent action necessarily comprises a 'harmonious combination' of these processes. Thus when an adult brushes the doll's hair, this routine can be reproduced by the child via direct imitation but also conforms to the child's play representations comprising knowledge of the act's meaning. However, if an adult models a counter-functional act, such as brushing a toy lorry, then one would expect a degree of conflict between imitative representations and the play representations which comprise meaning. Counter-functional play involves the use of a functional object in such a way that betrays its functional role e.g. the use of a spoon to 'brush' dolly's hair. The child's reproduction of a counter-functional act in response to an adult model gives an indication of prior representations of the object's functional role. Thereby, a tendency to imitate a counter-functional model suggests the relative strength of imitative representations in contrast to play representations.

The comparison between these two measures may indicate the relative strength of the child's representations and consequent need to attribute meaning to play acts. It is assumed therefore that children have two underlying competing responses, the first to produce a model which is consistent with the functional properties of the object, i.e. meaning, and a second response which is inconsistent with meaning but conforms to the model observed. In order for competing responses to exist, children must have existing play representations comprising knowledge of the object's functional properties. For example, if the adult models 'brushing' a doll's hair with a spoon then the child must have an existing functional representation of the spoon. Furthermore, this framework implies that children are restricted to functional representations. While play representations in young children are thought to be functional, older children may be able to attribute meaning to a range of seemingly abstract acts.

The framework established here provides us with an empirical tool to distinguish imitative representations and play representations. However, this distinction implies two provisos. First, it is important to demonstrate that the counter-functional model does conflict with the child's existing knowledge. Second, the framework for representational conflict may only be valid in young children who are predominantly restricted to functional play.

Given these qualifications, this framework may distinguish between the representational basis for play used by children with Down's Syndrome and typically developing children. The anomalies observed in the pretend play of children with Down's Syndrome may reflect the use of imitative representations which has been demonstrated in relation to objectpermanence.

12.1.1 Aim

The aim of the present study is to investigate the propensity for imitation of counter-functional play acts in children with Down's Syndrome and in typically developing children. This study aims, firstly, to establish that both groups, DS and NDS, are restricted to functional play and can demonstrate functional representations of play objects. Secondly, the aim is to investigate the claim that children with Down's Syndrome will be more likely to imitate a counter-functional model of play than typically developing children.

12.2 Method

12.2.1 Participants

The participants in this experiment were 18 children with Down's Syndrome (9 female, 9 male) matched for developmental age with 18 children without Down's Syndrome (9 female, 9 male). The BSID II was administered to assess the children's developmental ages for the purpose of matching. Testing for all children began at item 78 of the scales and was terminated either at item 148 or when the child had failed 10 consecutive items. Developmental and chronological ages for the two groups are shown in Table 12-1.

	DS n=18	NDS n=18
DA months (s.d.)	20.1 (7.5)	20.2 (8.1)
CA months (s.d.)	37.7 (14.2)	20.1 (7.8)

Table 12-1: Developmental ages and chronological ages of participants

To investigate the possibility of a global discrepancy between play and cognitive development an independent measure of pretend play was obtained. The test of pretend play (Lewis & Boucher, 1997) , or ToPP, was used as an assessment of children's ability to produce decontextualised play. The whole test comprises 4 sections of which only the first three were administered.

Scores on the ToPP and age equivalent scores for the two groups are shown in Table 12-2. The number of object substitutions (i.e. frequency with which one object was substituted with another) was also scored from the test data for each child in order to compare the frequency of such substitutions in the two groups.

	DS	NDS
TOPP Score (Sections I-III) (s.d.)	4.83 (2.15)	4.50 (1.86)
Frequency of Substitution (s.d.) (Max. 17)	1. 4 (1.5)	1.9 (1.7)
Age Equivalent months (s.d.)	19.0 (4.2)	18.3 (3.6)

Table 12-2: Scores, frequency of object substitutions, and age-equivalent scores on the Test of Pretend Play (TOPP)

Developmental trends in functional play suggest a decreasing reliance on similarity of play objects to functional objects (Ungerer, Zelazo, Kearsley & O'Leary, 1981). This process, which Piaget referred to as 'decontextualisation', reflects the fact that children are increasingly able to attribute properties to non-functional junk objects or indeed objects with a counter-functional role. Given our empirical requirement that children should be restricted to functional representations of objects, it was important to include this measure of symbolic play as a second check on our matching procedure. The age equivalent scores on the ToPP indicate no apparent discrepancy in symbolic play with respect to developmental age in either group. Furthermore, as Ungerer et al. (1981) report, children's play between 18 and 22 months comprises a low frequency of object substitution thus satisfying the requirement that play is largely dependent on the functional use of objects. The minimal frequency of object substitutions from our sample is apparent in Table 12-2.

12.2.2 Pilot testing of play materials

Extensive pilot testing was carried out with 22 typically developing children aged 14 months to 35 months (mean 23 months) to ensure a reasonable degree of spontaneous functional play with a set of test materials. During pilot testing, eight toy items were presented to children in the following order; a spoon, a hairbrush, a small flannel, a baby's bottle, a bath, a potty, a mirror, and a toothbrush. Two 'target' toys, a toy lorry and a doll, were also made available to the child. The purpose of pilot testing was to confirm that each toy item would elicit functional play with a small doll as opposed to the counter-functional pairing with the toy lorry. The two target toys, doll and lorry, were placed within the child's reach and the eight toy items were presented sequentially to the child. Following this 'spontaneous' condition, the items were presented to the child in sequence following counter-functional modelling by the experimenter. The experimenter modelled the act of 'brushing the lorry's hair' prior to presenting the brush item to the child. This condition was included to gauge children's imitation of a counter-functional model.

The first priority was to assess the frequency of children's functional play in the spontaneous condition. Children's play acts with each item were categorised as either functional or counter-functional under each condition. Figure 12-1 shows the percentage of children who engaged in functional play with each toy item in the spontaneous condition.

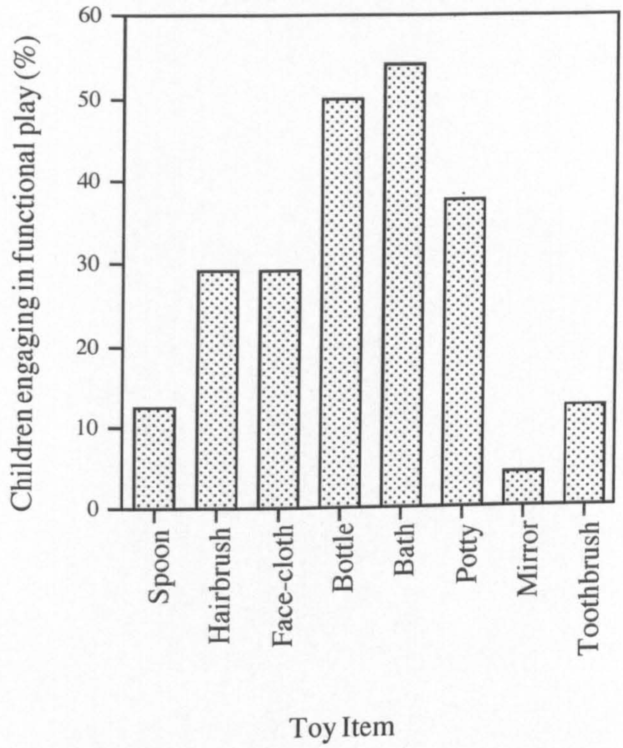


Figure 12-1: Proportion of children engaging in doll directed (functional) play in spontaneous condition (pilot testing)

The number of functional and counter-functional acts under each condition was also analysed in a two-way analysis of variance (target x condition). The main effect of condition was not significant ($F(1,23)=2.63$), nor was the main effect of target ($F(1,23)=0.00$, NS). However, the interaction was significant ($F(1,23)=18.23$, $p<0.001$), indicating a shift toward counter-functional play following a counter-functional model by the experimenter. These data were also analysed in order to determine the effect size pertinent to our hypothesis. The experimental hypothesis essentially predicts that children with Down's Syndrome are more likely to be influenced by the experimenter's model than children in the NDS group. Thus a difference between DS and NDS groups in the strength of the play type x condition interaction is predicted. The two-way interaction in the pilot data was taken as the best estimate of the size of the predicted three-way (group x play-type x condition) interaction in our experimental data. The effect size was

η^2 (partial) = 0.44. Thus, a smaller sample size of 18 per group would give a power of 0.98 (at α=0.05) according to data from Cohen (1988).

12.2.3 Apparatus

On the basis of pilot testing, the following items were selected for the current study: a spoon, a hairbrush, a small flannel, a baby's drinking bottle, a toy bath, and a toothbrush. Only one item, a mirror, was rejected from the pilot set due to its failure to elicit frequent functional play in more than 10% of children. A second item, the toy potty, was rejected on the grounds that it was unlikely to elicit functional play in young children who may not have been aware of its functional properties. Functional awareness would therefore have been confounded with the chronological age differences between our two groups if this item was included.

Two additional toy items, a toy comb and a small toy cup, were selected to complete a set of eight. It was presumed that these additional items, being similar in function to the pilot items, brush and bottle, would elicit a reasonable level of functional play. All items were the appropriate size for a doll of height 35 cm. Toy targets for children's play were a doll (height 35 cm) and a toy lorry (length 32 cm).

12.2.4 Procedure

All children were tested at home with one parent present. A video camera was placed in one corner of the room in order to record the child's activity during the experiment.

The experimental procedure began with an assessment of children's spontaneous functional play, referred to as the 'spontaneous' condition. Parents were requested not to prompt their children's play in a directive manner such as 'give dolly a drink' but to offer general encouragement. The target toys, the lorry and doll, were placed in front of the child approximately 0.5 metres apart and at a distance of 0.5 metres from the child. Children were presented with the functional toy items in the following order: a spoon, a hairbrush, a small flannel, a baby's drinking bottle, a toy bath, a comb, a cup, and a toothbrush. Items were placed between the two target toys and only one item was present at any one time. Children who failed to pick up the functional toy item spontaneously were encouraged by the experimenter who pointed at the item and said, 'what's this' or 'look'. Children who failed to produce any play with the functional item (either self or target directed) within 15 seconds were encouraged to look at the target toys by the experimenter who held target toys 0.5 metres apart and then replaced them in front of the child (see Figure 12-2). After 30 seconds the child was presented with the next item from the series. Testing continued in this manner with each of the eight toy items.

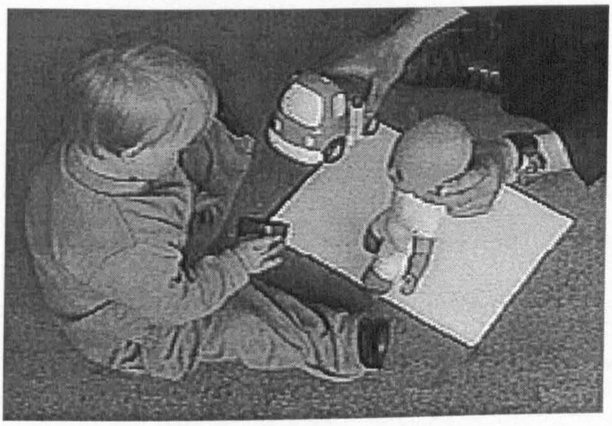


Figure 12-2: Position of child and experimenter with target items (lorry and doll shown)

A second experimental condition, 'modelled', involved the experimenter modelling a counter-functional play act for two to three seconds, waiting for two to three seconds, and then presenting the child with the toy item. Counter-functional play involved the toy item being paired with the lorry target as opposed to the doll as target. The experimenter would for example, place the toy drinking bottle at the front of the lorry and tip up the bottle as if to give the lorry a drink. Children were encouraged to watch the modelled acts by the experimenter saying, 'look at this', or, 'watch me' but the nature of the act, e.g. 'drinking', was not verbalised. After the presentation of a counter-functional model, the toy item was placed between the targets as in the previous condition and children were offered encouragement in a manner identical to this condition. This procedure was repeated for each of the eight toy items.

It is important to note that the order of the spontaneous and modelled conditions were not counterbalanced. Prior exposure to a modelled counter-functional act may have primed such an act in the subsequent condition and for this reason the spontaneous condition preceded the modelled condition.

12.2.5 Treatment of results

Video recordings of all experimental sessions were coded by the experimenter. Children's play was categorised according to the target of the play act which could be either the lorry, or the doll. Children occasionally produced a sequence of more than one identifiable play act within the 30 second period allocated to each item. All identifiable play acts were recorded in order up to a maximum of two sequential acts e.g. lorry as first target , doll as second target . Play acts were also coded as either 'accurate' or 'inaccurate'. In the case of functional acts, with the doll as target, accuracy was categorised according to the child's conformity with the functional properties of the toy item e.g. hairbrush used on the doll's hair rather than its face. In the case of counter-functional acts, with the lorry as target, accuracy reflected correspondence to the experimenter's model. It is important to note that, in the spontaneous condition, children would not have seen the experimenters model, and accuracy is to some extent arbitrary in this case.

Video recordings of 10 play sessions (28% of our total sample) were judged by a second rater, a psychology graduate. Cohen's Kappa was used to calculate chance corrected agreement on nominal play categories. For judgements of first play act, kappa $\kappa = 0.73$, for first and second play acts in sequence, $\kappa = 0.67$. For judgements of accuracy, $\kappa = 0.65$.

12.3 Results

The number of first play acts classified as either doll, lorry, or self- directed are shown in Figure 12-3, for the spontaneous condition and Figure 12-4, for the modelled condition. Play acts represented here indicate only the first act produced irrespective of subsequent play acts. While functional, doll-directed play is clearly more frequent in the spontaneous condition, lorry-directed, counter-functional play is most frequent in the modelled condition.

A three-way analysis of variance (target x group x condition) was carried out. The analysis reported a non significant main effect of group ($F(1,34)=3.24$) indicating a similar frequency of play acts in the DS and NDS groups. The main effect of target was significant ($F(1,34)=14.34$, $p<0.001$) indicating that the children produced fewer lorry-directed than doll-directed acts. The main effect of condition was not significant ($F(1,34)=3.78$, NS) indicating a similar frequency of play acts across both conditions.

The group x target interaction was not significant ($F(1,34)=0.18$) suggesting that there were no general differences in the distribution of target-directed acts between the two groups. Furthermore, the group x condition interaction was not significant ($F(1,34)=0.06$) indicating no group dependent difference in frequency of play acts between the spontaneous and modelled conditions.

As predicted, and consistent with our pilot results, the two-way target x condition interaction was significant ($F(1,34) = 62.8$, $p<0.001$) reflecting a difference in the distribution of target choice in spontaneous and modelled conditions. The current hypothesis suggests that children with Down's Syndrome should show an increased tendency to imitate a counter-functional act and such an effect is reflected in the three way interaction group x target x condition. The interaction was significant $F(1,34)=5.10$ $p<0.05$ and suggests that the change in the distribution of play acts with respect to condition was group dependent.

Pairwise Bonferoni adjusted t-tests between conditions confirm a significant decrease in functional, doll-directed play in the modelled condition in both groups ($t(17)=5.86$ $p=0.001$ for the DS group, and $t(17)=3.79$ $p=0.001$ for the NDS group). Both groups show a corresponding significant increase in counter-functional play in the modelled condition ($t(17)=6.27$ $p=0.001$ for the DS group and $t(17)=3.79$ $p=0.01$ for the NDS group).

It was important to establish the extent to which individual children maintained a level of functional play across the two conditions. Correlation coefficients were therefore calculated between the number of functional acts which each child produces in each of the spontaneous and modelled conditions. The greater tendency for children in the NDS group to maintain functional play in the modelled condition (i.e. choose the doll) is reflected in the correlation between functional acts across the two conditions $r=0.55$ $p<0.05$. The tendency for children in the DS group to exhibit correspondingly fewer functional acts in the modelled condition is reflected in the smaller correlation for the DS group, $r=0.34$, NS.

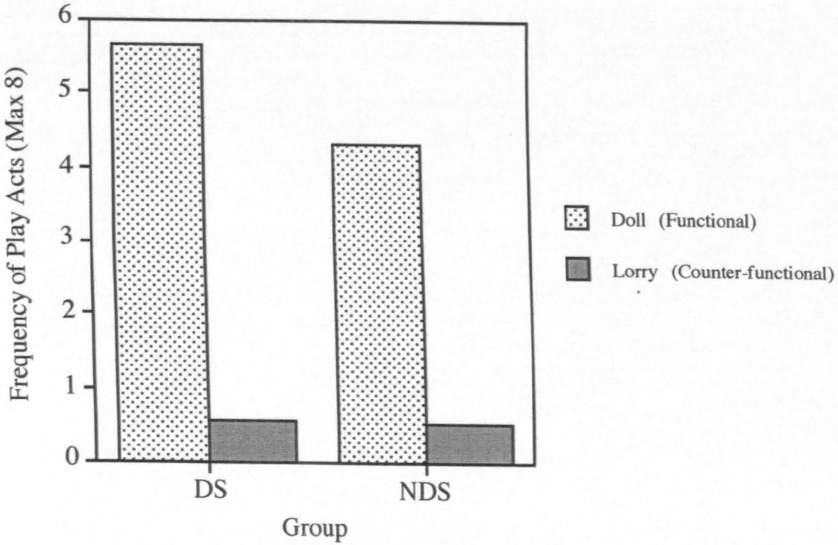


Figure 12-3: Frequency of toy directed acts in spontaneous condition (DS & NDS groups)

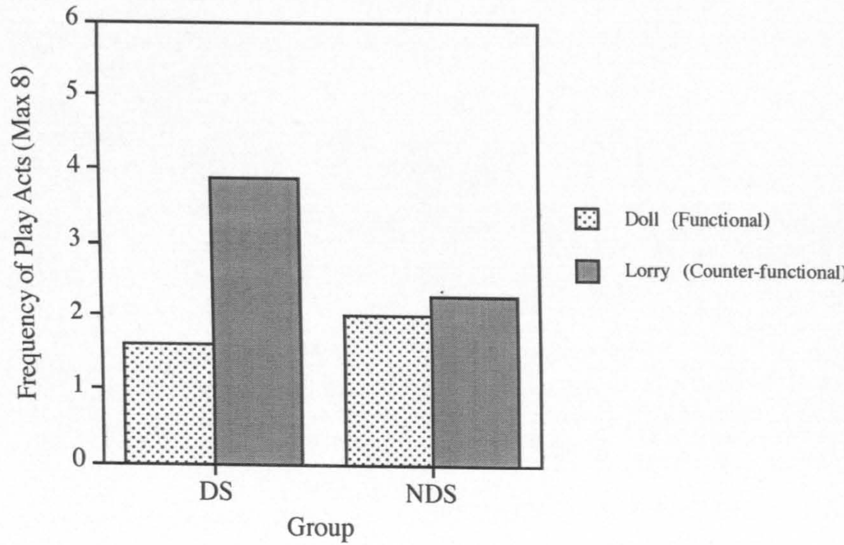


Figure 12-4: Frequency of toy directed acts in modelled condition (DS & NDS groups)

Table 12-3 shows the accuracy of play acts as a percentage of total acts produced within each condition and category. The data suggests that the most accurate acts in general are those which reflect imitation of the counter-functional act (lorry) in the modelled condition. In terms of the functional acts, the degree of accuracy is relatively high in both groups.

Condition	Target	DS	NDS
Spontaneous	Doll[2]	63 (34)	71 (34)
Modelled	Doll	65 (31)	66 (45)
Modelled	Lorry	85 (26)	81 (32)

Table 12-3: Percentage accuracy of target acts in spontaneous and modelled conditions (s.d.)

In summary, group effects show a relative shift towards counter-functional play in the modelled condition, more markedly so in the Down's Syndrome group. Imitation of a counter functional models appeared to be accurate and was a stronger feature of performance in the DS group compared to the NDS group. However, the experimental hypothesis, when strictly interpreted, demands that individual children within the Down's Syndrome group should be more likely to shift from a functional play act (in the spontaneous condition) to a counter-functional play act (in the modelled condition) with a particular toy item.

[2] The accuracy of lorry directed acts in the spontaneous condition are to a certain extent arbitrary as children had not yet been exposed to the counter-functional model (correspondence to this model determined accuracy). These results have therefore been excluded to avoid confusion.

Table 12-4 shows the frequency with which children's acts with individual items showed consistency or inconsistency across conditions.

Spontaneous condition	Modelledcondition	DS	NDS
functional	no play	1.4 (1.3)	1.2 (1.8)
functional	functional	1.4 (1.8)	1.6 (2.7)
functional	counter-functional	2.8 (2.5)	1.2 (1.8)

Table 12-4: Changes in play act between spontaneous and modelled conditions, DS and NDS groups(first play act only)

A two-way analysis of variance (group x shift-type) was carried out on the number of shifts made between conditions. The main effects of group ($F(1,34)=2.62$) and shift type ($F(1,34)=0.74$) were not significant. The group x shift-type interaction was not significant ($F(2,68)=1.93$). Thus, there is no significant difference between the DS and NDS groups with respect to the type of shift made. However, it would appear that children with Down's Syndrome produce relatively more specific shifts from functional to counter-functional play as a t-test confirmed $t(18)=2.22$ $p<0.05$.

The results thus far indicate a consistent change in relative frequency of play acts under the spontaneous and modelled conditions. Furthermore, the shift towards counter-functional acts under conditions of counter-functional modelling is consistently and significantly stronger in the children with Down's Syndrome. However, given that children often produced multiple play acts, the first act may have indicated an imitative 'reflex', independent of play representations.

A further analysis of second and subsequent play acts was carried out to examine play acts following such imitation. The cumulative frequency of play acts from both first and second acts is shown in Table 12-5.

Condition		DS	NDS
Spontaneous	Doll	5.9 (2.4)	4.3 (2.5)
	Lorry	0.6 (0.6)	0.5 (0.7)
Modelled	Doll	2.3 (2.5)	2.1 (2.8)
	Lorry	3.9 (2.1)	2.3 (2.2)

Table 12-5: Cumulative frequency of target acts in spontaneous and modelled conditions (i.e. including second and subsequent acts)(s.d. in parentheses)

The results show a striking similarity to our previous results (Figure 12-3 & Figure 12-4) despite the inclusion of second acts. The relatively small change reflects the infrequency with which children made two target directed acts in sequence with a single toy item. A three-way analysis of variance confirmed the same pattern of significant results as our previous analysis. Notably, the three-way interaction group x target x condition remained significant $F(1,34)=4.56$, $p<0.05$.

12.4 Discussion

The results presented in this chapter suggest that, under spontaneous play conditions, children with Down's Syndrome show a similarly high frequency of functional play as children without Down's Syndrome. This broad similarity in proportion of functional play acts is consistent with other empirical studies (McConkey, 1985; Beeghly, Weiss-Perry & Cicchetti, 1990). In contrast, in response to a counter-functional model, children with Down's Syndrome produced a counter functional response more often than typically developing children.

The first analysis included only the first target directed act which children produced with each toy item. If a child produced two target directed acts only the first would contribute to the analysis. It cannot be concluded from this analyses that imitation of a counter-functional act is in *competition* with a functional response merely that imitation is the preferable first response. Such a pattern is often observed in typically developing children's performance on two location (AAB) object permanence tasks. In this case, a prepotent impulsive reach to location A (based on a representation of a previously successful action) is followed by a second reach (based on a representation of the hidden object) to location B. In the case of the object permanence task such a pattern is indicative of a failure to inhibit the prepotent response (Diamond & Gilbert, 1989).

It is possible therefore that the imitative response which is seen predominantly in the DS group does not impinge on play representations. This possibility was addressed directly by considering acts directed at each target in sequence. If imitation is simply an impulsive reaction to the adult model, and does not interfere with underlying functional representations, then it should not impair subsequent functional play. The similar pattern of results which emerged despite inclusion of all target related play indicates the rarity with which children combined both functional and counter-functional acts with the same play object. The apparent mutual exclusivity of functional and counter functional play indicated responses are in direct competition rather than being independently activated.

The strict interpretation of this argument for 'mutual exclusivity' in representations requires that individual children, while possessing a functional representation for a particular item, imitate a counter-functional model. While group trends suggest such a process, this does not necessarily reflect representational shifts within children. Our final analysis addressed this issue and compared each child's play with each item in the spontaneous condition with the child's play for the same item in the modelled condition. The fact that children with Down's Syndrome showed more frequent shifts from functional to counter-functional play suggests that representations gain exclusive control over the child's action. In the modelled condition, the play of children with Down's Syndrome is driven by imitative representations.

It was suggested in the introduction to this chapter that the response to the counter-functional model is mediated by competition between an imitative representation and a play representation. In the modelled condition children hold an imitative representation of the experimenter's model and a play representation which was expressed in the spontaneous condition. The functional play representation evident in the spontaneous condition must therefore compete with a representation of the experimenter's action. The modelled action is counter-functional and given that our sample are developmentally inclined towards respecting the functional properties of objects, the model should be in conflict with their play representations. Typically developing children respond to the modelled condition with a reduction in functional play and a corresponding shift towards imitation of the counter-functional act. However, in children with Down's Syndrome this shift is significantly more dramatic. Our interpretation of these results is that children with Down's Syndrome have a general tendency to imitate which is exerted in preference to deploying functional representation. The corollary of this conclusion is that play representations in children with Down's Syndrome are weaker than in typically developing children and are therefore more easily supplanted by imitation.

Before elaborating on the implications of this conclusion there are a number of crucial objections to the current claims about which need to be addressed. There are a number of potential problems with our line of argument:

a) *Functional play is not representational and therefore there is no representational violation in imitation of a counter-functional act.*

It is argued in this chapter that functional play, while not requiring the same level of representation as symbolic play proper, does require some form of representation. Leslie's (1987) distinction between functional play and symbolic play was couched in terms of requirements for secondary representation. Play with a functional object may not require a secondary representation which is radically different to the primary representation - as when pretending a banana is a telephone. However, functional play does require some representation of the functional properties of the object within a primary representation. The requirement that only symbolic acts, as opposed to functional play, may be regarded as representational may be over conservative (Jarrold, 1997). Support for continuity in representational basis for functional and symbolic play comes from evidence that children with autism show a deficit in both symbolic and functional play (Lewis & Boucher, 1988; Sigman & Ungerer, 1984; Jarrold, Boucher & Smith, 1996)

One of the principal difficulties in empirical studies of representation is classifying the criteria for behaviour which is 'representational'. In the case of symbolic play the distinction between representational play and simple manipulative play is complex and often subjective. While one child may place a stick in a jar in order to represent 'stirring a cup of tea' another child may be interested solely in the manipulation of the objects in a similar manner. However, functional play acts, while not strictly symbolic are unlikely to reflect simple chance manipulations. The high levels of accuracy with which children reproduced both functional and counter-functional acts does not support an argument for chance manipulation. The representational status of functional play is certainly weaker but even functional acts must require children to encode knowledge of an object's properties in relation to their actions.

Functional play objects such as a doll and hairbrush have clear 'representational' properties[3] and clearly definable functions. The child's tendency to produce functional play with a functional object therefore reflects the child's conceptual representations of its use.

A second point which relates to the distinction between symbolic and functional play is that many of the studies which report the lower quality and repetitive nature of play in children with Down's Syndrome are based on functional rather than symbolic play (Beeghly, Weiss-Perry & Cicchetti, 1989; Krakow & Kopp, 1983). Despite referring to 'symbolic play' it appears that Krakow and Kopp's (1983) study is pointing to differences in play with functional objects.

b) *The ability of children with Down's Syndrome to imitate a counter-functional act indicates the ability to perform object substitution. i.e. use one object as though it were another. The relative frequency of counter-functional play in children with Down's Syndrome therefore indicates a relatively advanced representational system.*

Piaget referred to the child's growing ability to play symbolically with objects which are not realistic as decontextualisation. The act of feeding a lorry could be seen as indicative of decontextualisation. However, the ability to decontextualise objects from clear functional properties in a counter-functional way is arguably more advanced than the use of junk objects, with no clear functional role, as if they were something else (Jarrold, Boucher, & Smith, 1994). The argument for advanced play in the DS group is not supported by results of the ToPP symbolic play test which show performance closely matched to the NDS group. Furthermore, results from the ToPP showed only minimal evidence for decontextualised symbolic play in either group.

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[3] I use the term representational here in its loose sense. i.e. a mini hairbrush is a representation of a real hairbrush but does not *necessarily* have representational status for the child (c.f. Perner, 1991).

c) Children with Down's Syndrome prefer to imitate

The argument that children with Down's Syndrome simply prefer imitation, enjoy imitation, or are more highly motivated to imitate is, at first inspection, problematic for our interpretation. However, we can equally argue that typically developing children 'prefer to play' as both arguments are simple tautologies. As we noted in our introduction there is a broad consistency between representational, motivational, and social explanations for behaviour. According to White (1969) and Harter (1974) children are motivated to display underlying competence in particular areas. This could equally well be translated as a motivation to develop and deploy knowledge at the representational level. Play, in particular, is widely held as an example of children simply playing for the sake of it and appears to be sensitive to children's motivational status (Hrncir, Speller & West, 1985; Yarrow, Morgan, Jennings, Harmon & Gaiter, 1982).

Karmiloff-Smith (1992/1995) argues for the importance of behavioural mastery in strengthening the explicit basis for representation. To answer the initial objection that children with Down's Syndrome prefer imitation to functional play one could argue that it is precisely because children with Down's Syndrome prefer imitation that play representations become weaker. Conversely one could equally argue that a weakness in symbolic representation is the cause of the motivational preference for imitation.

The results presented in this chapter suggest a preference for imitation of counter-functional acts in children with Down's Syndrome which disregards and interferes with children's representations of the object's functional role. In terms of our experimental procedure, imitation and functional acts appear to have the same representational basis and therefore compete for exclusive control of the child's action. The results show that when faced with such competing tendencies, children with Down's Syndrome appear to prefer the imitative response over a response based on functional play representations. It is argued that this pattern of performance reflects a pattern of representational strengths and weakness, a relative strength in imitative representations and relative weakness in functional play representations.

The existence of representational dualism was referred to in the introduction to this chapter. It was argued that pretend play, either functional or symbolic, may require a combination of imitative and play representations. Certainly, imitative representations must play a role in the acquisition of models for pretence (see Rogers & Pennington, 1991). However, it is argued that the tendency for children with Down's Syndrome to override existing functional play representations with novel imitative representations suggests a fundamental relative weakness of play representations. Meltzoff and Gopnik (1989) argue that empirical representations (including imitation) are superseded by hypothetical representations around 18 months in typically developing children but this period may be delayed in children with Down's Syndrome. There are a number of theoretical reasons to believe that a tendency to imitate may be counterproductive to development. The Piagetian view of accommodation without assimilation suggests that the child continually incorporates new schemes but without understanding or integrating existing schemes. Karmiloff-Smith's view of representational development also suggests the need to achieve behavioural mastery if representations are to be consolidated and integrated.

12.4.1 Summary

The ease with which existing representations are supplanted by imitation reflects an underlying weakness and a lack of integration of functional representations in children with Down's Syndrome. This relative weakness of a functional representational basis for play may explain the inability of children with Down's Syndrome to generate elaborate and creative play acts. The anomalies reported by Krakow and Kopp (1983) regarding the rigid, stereotypical play of children with Down's Syndrome may also reflect a weaker representational basis.

Furthermore it is argued that the primacy of imitative representations over play representation may reflect both a cause and a consequence of weaknesses in play. The tendency to accumulate new representations, rather than strengthen and elaborate existing representations could result in a failure to reinforce existing representations. Karmiloff-Smith's model of 'representational redescription' views the achievement of behavioural mastery as synonymous with the development of stronger representations via a transition to explicit forms. Therefore, a failure to achieve behavioural mastery necessarily results in weaker, implicit representations. Furthermore, we suggest that this weakness is exaggerated by a tendency to play by imitation rather than for mastery of play itself. This distinction is clearly characterised by Piaget's view of 'pure play', as assimilation, and 'pure imitation', as accommodation. The primacy of accommodation over assimilation is seen as counterproductive to development and results in the accumulation of experience without integration or reinforcement.

In the following chapter the results of the preceding empirical studies are reviewed with reference to development in children with and without Down's Syndrome. The contribution of these studies to an understanding of typical representational development is summarised. Furthermore, it is argued that anomalies in the representational development of children with Down's Syndrome may require focused intervention to ameliorate counterproductive learning strategies.

Chapter 13

General Discussion

This thesis set out to investigate representational development in children with Down's Syndrome. While many domains of development such as language and play development are circumscribed for the purposes of empirical study, such domains may be linked at the representational level. A focus on representation has therefore allowed us to identify those facets of development which should be closely linked in theoretical terms. Many meta-developmental theories suggest a modular or global nature to representational development and specify the processes which drive representational development (Piaget, 1953/1970; Karmiloff-Smith, 1992/1995; Fodor, 1983; 1989). Models of development in children with Down's Syndrome imply that similar structural constraints should apply to those implicated in typical development. The empirical work in this thesis has therefore focused on hypothesised cross-domain links derived from theoretical approaches to, and empirical studies of, typically developing children. Furthermore we have attempted to identify those links which appear anomalous or vulnerable in the light of evidence from the developmental profile of children with Down's Syndrome.

This chapter attempts to draw together the results from our empirical studies and considers the nature of representational development in children with Down's Syndrome. Furthermore we attempt to relate the developmental characteristics of representation in infants with Down's Syndrome to developmental theory. Finally we consider how interventions may benefit from a greater understanding of representational processes in children with Down's Syndrome.

13.1 Review of studies reported in this thesis

In our first empirical chapter, chapter 8, we investigated the stability of cognitive performance in children with Down's Syndrome in comparison to a group of typically developing children matched for developmental age. This study, in contrast to other studies, included a control group and the data suggest a comparable level of stability in children with Down's Syndrome and in typically developing children. However, there is a suggestion in the data that the pattern of instability in children with Down's Syndrome may be different to that of typically developing children. It appears that children with Down's Syndrome show less reliability on those items which, as a group, these children find relatively easy.

Chapter 9 investigated the relationship between the motor development of children with Down's Syndrome and performance on object permanence tasks requiring sophisticated spatial representation. The finding that some children appear to perform two location search tasks prior to self-generated locomotion suggest that motor development does not necessarily limit spatial representation in children with Down's Syndrome. However, it remains a possibility that performance on object permanence tasks is not a reliable indicator of a child's spatial representation and subsequent studies addressed this question.

In chapter 10 the relationship between conceptual and linguistic development in children with Down's Syndrome was investigated. The general finding that linguistic reference tends to lag behind cognitive development in children with Down's Syndrome is not supported by these data. Again this result may be explained by results from the following studies which suggest that performance on object permanence tasks may not reflect the same conceptual understanding as indicated in typically developing children.

In chapter 11 it was argued that, given the apparent strengths and weaknesses in their developmental profile, it would be surprising if strategies adopted by children with

Down's Syndrome in solving object permanence tasks corresponded to those adopted by typically developing children. Furthermore, evidence for lower motivation and engagement in object permanence tasks coupled with anomalous error patterns suggests that children with Down's Syndrome may differ in their approach to tasks in general (Wishart, 1993a; 1993b; Wishart & Duffy, 1990; Morss, 1993). Given the strength of development in the social domain, it was proposed that children with Down's Syndrome may use imitation as a strategy to solve object permanence tasks.

In study 3, children with Down's Syndrome were found to be in advance of typically developing children in imitation relative to object permanence. In study 4, the lever study, children with Down's Syndrome, in contrast to typically developing children, were found to be impaired on a task which precluded a solution by imitation.

Taken together, these studies suggest that children with Down's Syndrome use their imitation as a strategy for solving object permanence tasks. Furthermore, the use of imitation in this context may reflect a 'lower level' of conceptual engagement in object permanence tasks.

The final study, study 5 (Chapter 12), extends the findings with respect to object permanence to the domain of symbolic play. Although children with Down's Syndrome were found to produce a similar number of functional play acts to typically developing children under spontaneous conditions, they were more likely to imitate the experimenter's counter-functional model. It is argued that the apparent ease with which children with Down's Syndrome accept a counter-functional model suggests an underlying weakness in functional representations which underpin emerging symbolic play.

In summary, these experiments were designed to address particular developmental anomalies which have emerged in studies of children with Down's Syndrome. These anomalies suggest discrepancies between the structural organisation apparent in typically developing children and that which governs the development of children with Down's Syndrome. The atypical nature of development in children with Down's Syndrome therefore serves to illustrate that there are alternative ontogenetic pathways (cf. Cicchetti & Beeghly, 1990). However, it appears that, given the slower pace of development in children with Down's Syndrome relative to typically developing children, the path which these children follow is far from ideal.

In the following section the implication of the current findings are discussed with respect to both children with Down's Syndrome and theoretical approaches to development. Furthermore, the implications for intervention and further research will also be discussed.

13.2 Representational development and learning in children with Down's Syndrome

The performance of children with Down's Syndrome on object permanence tasks and symbolic play suggests the adoption of a developmental style which is distinct from typically developing children. It is important to consider how such a style could arise and consider its developmental implications. This section begins by re-examining models of development within the Down's Syndrome population and subsequently focuses on the theoretical implications for representational development in general.

13.2.1 Delay vs. difference controversy revisited

This thesis began with a discussion of models of development in children with Down's Syndrome. Many models take a global perspective and so necessarily reflect the general coherence and broadly typical organisation which characterises children with Down's Syndrome (Cicchetti & Beeghly, 1990). The 'delay vs. difference' controversy which outlines the distinction between a global and specific delay is widely held to be a misnomer (Zigler & Balla, 1982). Even those advocating a delay view must account for this delay by positing some differences in the learning process. Some models, while specifying a circumscribed deficit, are nonetheless inclined to reflect a generalised slowing down of developmental processes in children with Down's Syndrome (Wishart, 1996a; 1996b; Nadel, 1996; Krakow & Kopp; 1983).

Despite the tendency to characterise development in children with Down's Syndrome as globally delayed, a number of studies have investigated the pattern of learning in children with Down's Syndrome, in contrast to assessing absolute levels of performance (Wishart, 1996a; 1996b; Krakow & Kopp, 1983). Despite a developmental progression which is similar in terms of sequence and structure to that of typically developing children, there do appear to be a number of differences in the style with which children with Down's Syndrome acquire, consolidate and demonstrate new skills. These differences may explain the slower developmental progression which typifies development in children with Down's Syndrome. The results presented in this thesis are broadly consistent with findings which suggest a reduced mastery motivation, an avoidant learning style, failure to consolidate learned skills, or a dampening of epistemic curiosity (Gunn, Berry, & Andrews, 1994; MacTurk, Hunter, McCarthy, Vietze, & McQuiston, 1985; Wishart, 1996a; Rast & Meltzoff, 1995). However, it is suggested here that such qualities are related to representational development.

13.2.2 Representational development

On close inspection it appears that the representational basis which guides the performance of children with Down's Syndrome on a number of tasks may be far from typical. Children with Down's Syndrome may have strengths and weaknesses in their developmental profile which corresponds to an atypical representational profile. While development within linguistic and cognitive domains is often seen as deficient and consequently receives attention from empirical studies, the relative social strength, as it applies to task performance, is rarely considered (see Hodapp, 1996, for a discussion of strengths and weaknesses). However, some authors have begun to recognise the ways in which social 'strengths' may impinge upon, or indeed impede, the learning process (Wishart, 1993a; Rast & Meltzoff, 1995). For example, children may deploy 'party tricks' or stereotypical social routines in order to avoid difficult tasks (Pitcairn & Wishart, 1994). The studies described in this thesis suggest that there may be a fundamental conflict between skills within the social domain and developmental progress within other domains.

The lack of attention which has been paid to the relative social strength in children with Down's Syndrome stands in contrast to studies of children with autism where a social deficit is seen as having a causal influence on development within a number of domains (Hobson, 1993; Rogers & Pennington, 1991). Conversely, one could argue that, given the pervasive nature of a social dimension across a range of apparently 'cognitive' tasks, the relative strength of children with Down's Syndrome in the social domain may disguise underlying weakness.

The relative strength of social development of children with Down's Syndrome may interfere with underlying developmental processes via an excessive use of imitative representations during infancy. Whilst imitation forms only a limited part of what is broadly characterised as a social strength, imitation itself is regarded as relatively well developed in children with Down's Syndrome (e.g. Hodapp, Leckman, Dykens, Sparrow, Zelinsky & Ort, 1992). Furthermore, imitation may be a causal influence on the perceived sociability of these children (Ruff & Rothbart, 1996; Gibbs & Thorpe, 1983).

It appears that children with Down's Syndrome use strategies based on imitative representations in contrast to the strategies which characterise the performance of typically developing children. The strength of imitation often results in a successful outcome on standard tasks such as object permanence or within symbolic play. However, the use of imitative strategies is reflected in the pattern and quality of performance within these domains. A tendency towards imitation in search may impede the generation of hypotheses concerning the object's location. When forced to generate hypotheses in order to search, or search solely on the basis of the object's location, children with Down's Syndrome appear characteristically impaired. Furthermore, the tendency to imitate rather than generate acts from existing representations was also observed in our study of symbolic play in children with Down's Syndrome. The tendency to imitate is not merely an isolated representational strength but may reflect the corresponding weakness of other representations. A weakness in underlying symbolic representations may therefore be reflected in the poor quality of spontaneous symbolic play in children with Down's Syndrome.

13.2.2.1 Strengths and weaknesses in representational development

Imitation clearly has an important role in typical development but its relative strength and exaggerated strategic use in children with Down's Syndrome may be counterproductive to learning and to general representational development. In this section, it is argued on theoretical grounds that imitative representations may contribute to the weakness of other representational systems.

To adopt Piagetian terminology, imitation is an extension of accommodation, while play is a characteristic of extended assimilation. Assimilation, according to Piaget, results in the integration of existing schemes with other schemes acquired in isolation. Assimilation entails the interpretation of new situations on the basis of existing representations and results in the ability to comprehend such situations. Without assimilation, pure accommodation leads to poor comprehension and integration of freshly acquired schemes. Children with Down's Syndrome may therefore tend to accommodate new schemes without the corresponding assimilation process. This developmental processing bias is one way in which a representational weakness could arise.

Karmiloff-Smith's (1992) view of representational development is termed representational redescription. According to Karmiloff-Smith, representations are strengthened via the achievement of behavioural mastery within a particular microdomain. Karmiloff-Smith describes domains as circumscribed areas of knowledge such as physics, or language, whilst microdomains comprise facets of knowledge within these domains such as gravity or definite articles. Once the child has achieved behavioural mastery of a particular microdomain, the representations reach a state of stability and the process of representation is driven endogenously in response to this success. The process of representational redescription results in the transformation of representations from implicit to explicit forms. The strength of explicit representations is reflected in the integration with other sub-domains and domains of development. The process of redescription results in the transformation of a circumscribed representation and a corresponding proliferation throughout other domains.

Karmiloff-Smith (1992) argues that children with Down's Syndrome may show a characteristic failure to develop sufficient behavioural mastery to facilitate representational redescription. Karmiloff-Smith describes a nine-year-old boy with Down's Syndrome, M. G., who appeared to have to relearn tasks such as beam balancing and drawing a house on each occasion he approached them. Such inconsistency in performance, although not evident in our study, may result in a failure of representational redescription.

Karmiloff-Smith argues that children with Down's Syndrome appear to relearn tasks afresh each time, suggesting a failure to achieve a consistent level of mastery. Many of the characteristics of play in children with Down's Syndrome suggest a similar failure. The reduced mastery motivation indicated by repetitive stereotyped play is reminiscent of Karmiloff-Smith's description of someone beginning to play a piano piece prior to achieving mastery. The achievement of mastery is fundamental to representational redescription, a process which results in the linking of knowledge across subdomains, strengthening and integrating that knowledge.

Many authors point to the motivational characteristics of Down's Syndrome as a potential cause of the reduced rate of development in the population. The extent to which a representational account of development in children with Down's Syndrome is plausible depends to some extent on its concordance with motivational accounts. Karmiloff-Smith's model serves to illustrate how motivational and representational explanations of Down's Syndrome may be equivalent. The evidence for representational anomalies in children with Down's Syndrome will now be considered with respect to studies which suggest differences at the motivational level.

13.2.2.2 Representation, imitation and motivation

Karmiloff-Smith's model allows us to view a motivational deficit as a causal element in a failure to strengthen representations. However, the underlying weakness of representations could conversely be seen as causing a reduced level of engagement in task performance. The question that remains to be addressed is how might relatively weak representations affect children's performance.

Munakata, McClelland, Johnson and Siegler (1994) introduce the possibility of a 'gradualistic' approach to the representations which drive children's search behaviour. Weaker representations are able only to facilitate recoveries which have moderate means-ends planning demands. Conversely, the existence of stronger representations facilitates more complex retrievals. There is evidence to suggest that the underlying weakness of representations in children with Down's Syndrome may influence performance in just this way. Wishart (1995) describes a child who demonstrated failure on an object permanence task when searching for chocolate buttons placed flat side down on the table. The child's difficulty with picking up the chocolate was seen as the cause of this failure, and was remedied by placing the buttons upside down to allow the child to pick them up. One could equally view this example as an illustration of weak representations failing to drive what initially may have been a complex retrieval process. Furthermore Wishart (1993b) describes the recovery of children's search success in response to chocolate, after a string of failures with an inedible hidden object. While this result is intuitively viewed in motivational terms, one could argue that hiding chocolate increases the representational salience of the hidden 'object'. In our own study, the pressing of the lever to recover the hidden ball, was possible for all but one child (in the DS group) when there was only one location. However, the task proved to be too complex for children with Down's Syndrome in the three location condition. The problem is not simply that the means-ends task was too complex but that it was too complex to be driven by a correspondingly weaker representation of the object's location.

Other, more general accounts of the motivational deficit in children with Down's Syndrome suggest a reduced level of mastery motivation or causality pleasure (Gunn, Berry, & Andrews, 1981; 1982; Ruskin, Mundy, Kasari & Sigman, 1994). Furthermore, the complexity of children's play appears linked to the enjoyment which they appear to get from it (Jennings, Harmon, Morgan, Gaiter & Yarrow, 1979). The mastery motivation account suggests that children who are highly motivated tend to derive a great deal of pleasure from their successes. One could argue that the lower engagement with tasks and reduced motivation reflects the underlying weakness of children's representations. The weakness in representational basis may result in correspondingly reduced contingent affect when this representation is expressed. Thus, a child combing a doll's hair will derive more pleasure from this activity if it is based on a relatively strong representation. The reduced affect which characterises task performance in children with Down's Syndrome (e.g. Dunst, 1981) may reflect the weakness of representations which are expressed.

Rast and Meltzoff (1995) refer to a 'dampening of epistemic curiosity' in children with Down's Syndrome which results in anomalous behaviour on object permanence tasks. It is argued here that it may not be the curiosity which is dampened but the epistemology. Thus the child's knowledge of the objects location is weakened, via a weaker representation, and this results in reduced motivation to retrieve the object. Clearly, accounts citing either a motivational or a representational basis for task performance are closely related. The purpose of the preceding discussion is to illustrate that a representational account of development is broadly consistent with empirical evidence for reduced motivation in children with Down's Syndrome. These accounts therefore make similar empirical predictions but may differ both in aetiology and implications for intervention.

13.2.3 Consequences for intervention

It has been argued in this thesis that children with Down's Syndrome may perform tasks using a different set of skills than typically developing children matched for developmental age. Therefore, while children with Down's Syndrome may appear to have reached a similar end-point to typically developing children, the processes by which children arrive at this end point may differ between the groups.

It is argued that children with Down's Syndrome may be solving tasks according to a different developmental protocol using a different representational basis. The relative strength of imitative representations in children with Down's Syndrome may supersede the representational structures which are used by typically developing children in solving tasks. Furthermore, it has been argued that the habitual reliance on imitative representations may serve to further reinforce the relative weakness of other representational structures. The empirical evidence from cross-sectional studies in this thesis supports the relative strength of imitative representations at particular points in time. However, it is argued that these data indicate that imitation may be a causal pathological process in the representational development of children with Down's Syndrome.

While many intervention strategies seek to emphasise and use children's strengths or assets (Gibson, 1996) it may be that the spontaneous use of such assets is the very feature which is impeding development in children with Down's Syndrome. According to Karmiloff-Smith, the process by which representations are strengthened is driven by the achievement of behavioural mastery. If behavioural mastery in particular domains is prevented by the primacy of imitation, then perhaps the balance could be redressed in intervention.

Encouraging children to exercise their weaknesses in intervention may lead to the achievement of behavioural mastery and therefore correct any imbalances in representational development. In practical terms such intervention may entail redesigning toys and educational materials so that play necessitates mastery within the weaker domains. Furthermore, tools for developmental assessment also need to reflect children's ability to perform a particular task but account for differences in the methods and learning styles that children might deploy. It would appear, for example, that object permanence tasks administered in the standard procedure may overestimate the cognitive abilities of children with Down's Syndrome. A more reliable assessment of object permanence may therefore be obtained using tasks, such as the lever task used in study 4, which prevent imitative solutions. The empirical studies detailed here emphasise the need to account not only for success or failure but the means with which children succeed on tasks. Therefore the success of intervention should be measured not only in terms of success on standard tasks but in terms of the adoption of a particular approach in achieving such a solution.

However, there is a clear paradox here, since the encouragement of routines which highlight children's weaknesses is all the more likely to expose children to failure. Any radical redesigning must therefore take account of the sensitivity of children's motivation and start at a level of performance which is within the child's threshold.

Despite some suggestions which are clearly different to those prescribed to address motivational difficulties, some approaches are common to both accounts. Wishart (1991) argues that children with Down's Syndrome need encouragement to reinforce newly learned skills. Any encouragement which results in the achievement of mastery rather than a one off success is certainly to be recommended. If we accept the converse of Munakata et al.'s (1994) findings, increasing the means-ends load at which success is achieved may strengthen the underlying representation. For example, if we take the case of the lever task, once the child has solved the single lever condition at all levels, one might require the child to press two levers simultaneously to retrieve the hidden object. The strength of children's representations could be similarly be periodically checked by increasing the means-ends or information processing load. Thus by increasing the information processing or means-ends skill required to solve a particular task may in itself strengthen the representation on which the solution is based.

The data presented in this thesis are based on cross sectional studies and it is suggested that the relative imitative strength observed in children with Down's Syndrome might reflect socio-cognitive processing biases which differs from typically developing children. However, longitudinal research is necessary to establish the extent to which 'imitativeness' is a genuine developmental trait which has causal implications for representational development in other domains. In particular, a training study could establish the extent to which experience of non-imitative solutions may have benefits for performance on object permanence tasks. Further research is also needed to examine the extent to which imitation may be prevalent in other domains of development beyond symbolic play and object permanence. Furthermore, the extent to which imitativeness may be characteristic of children with Down's Syndrome also needs to be established through studies of other atypical populations.

13.3 Conclusions

The results of our empirical studies suggest a degree of coherence in the structural relationship between linguistic and cognitive domains in children with Down's Syndrome. However, it appears that children with Down's Syndrome may exploit their relative strengths in imitation in performing cognitive tasks. Children with Down's Syndrome appear to have a capacity for imitation which may be deployed to solve object permanence tasks. Furthermore, the relative strength of representations which drive imitative performance may overshadow weaker representations such as memory for an object's location during search or an object's functional properties during play.

Results of studies in this thesis support a gradualistic and domain specific view of representational development in children with and without Down's Syndrome. Children with Down's Syndrome appear to have relatively strong social representations which facilitate imitation while representations of objects and functional properties in play are relatively weak.

In general terms, it appears that children with Down's Syndrome, when faced with standard developmental tasks, may use strategies which are qualitatively different from typically developing children. These findings cast doubt on traditional methods for matching of children with Down's Syndrome to control groups. Furthermore, the differences in the cognitive-developmental process may have implications for intervention.

From the point of view of intervention, we suggest that the relative strength in social representation may be a causal influence on weakness within other domains. This may have consequences for intervention strategies in children with Down's Syndrome.

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Appendix A

Ethical issues

A.1 Recruitment of participants: briefing (deception), consent, and right to withdraw.

The recruitment of participants is often regarded as an important methodological issue as the way in which a sample is obtained may have consequences for empirical validity. In this section recruitment of participants is considered as an issue of consent. Parents giving proxy consent for their children's participation may not be fully aware of their rights and may be coerced at the recruitment stage. Under particular circumstances, parents may feel that they are duty-bound to give consent and may be unaware of a number of their rights (Harth & Thong, 1995). The status of this research in being sponsored by the Down's Syndrome Association was considered to be potentially coercive to parents of children with Down's Syndrome who may have felt they had a duty to participate. The way in which parents were briefed as to the nature of the research, and their rights as participants, is therefore particularly important and forms an integral part of obtaining consent.

Children with Down's Syndrome were recruited largely through contact with local parental support groups. Initial contact was made with a group leader and in each case a prearranged visit was made to a group meeting. During the meeting the purpose and goals of the research were outlined and those interested in participating were given specific details of the relevant project. Specific reference was made to the fact that the research was intended to investigate the development of children with Down's Syndrome but was *not* intended to be of benefit to individual children (see BPS code of conduct p. 2, section 3.3). Recruitment of typically developing children was made though local parent and toddler groups. The group leader was contacted and an arrangement was made to visit the group. The purpose and goals of the research were explained either to individual parents or to the group, depending upon the number of parents present.

After explaining the project, parents were given contact details for the researcher or where parents expressed enthusiasm, were asked to provide a contact telephone number. During a subsequent telephone conversation, the researcher answered any outstanding questions. If the parents expressed interest in the project at this stage, an arrangement was made to visit the parent and child at home. If however, parents did not express particular interest in the project, they were not subsequently contacted. Particular attention was paid to limit any coercion during group meetings or at toddler groups and it was emphasised that there would be no payments for participation. Parents who gave consent, but later appeared unwilling to participate were given additional opportunities to withdraw their consent.

Due to the time consuming nature of the recruitment process, particularly that involving children with Down's Syndrome and typically developing children of specific chronological ages, parents and children often took part in more than one study. On each occasion, further consent for participation was requested from the parent.

A.2 Consent of Child

Given the age of the children involved in these studies, it was not possible to obtain direct verbal consent to participate. Consent by proxy was therefore obtained from parents. However, distress during empirical procedures was taken as a serious expression of children's discontent and unwillingness to participate. Evidence suggests a longer latency and reduced intensity of affective expression in children with Down's Syndrome (Cicchetti & Beeghly, 1990). Any signs of distress therefore warrant particular attention within the Down's Syndrome population. During recruitment, parents were informed that it was expected that children would enjoy participating in the studies. It was also emphasised that if children became distressed during the procedure then testing would be curtailed. Parents were further reminded prior to the empirical procedure that they should inform the researcher at any stage if the child was becoming distressed. The purpose of this reminder was not intended to serve as a substitute for the researcher's judgement but as supplementary to it.

A.3 Debriefing

Debriefing of parents followed each visit. Parents were reassured that information acquired during the experiment, such as developmental ages and other performance measures, would be treated as 'confidential'. Furthermore, parents were assured that children would not be identified by name in published research material (BPS code of conduct p. 10, section 7.1). Additional consent was requested for empirical studies involving the use of video tapes, particularly where pictures were intended for publication.

Throughout the debriefing processes an effort was made to ensure that the parent understood the nature of the study. In studies where data collection was spread over several visits a full debriefing, including a statement of the particular empirical hypothesis, was reserved for the final visit. However, where parents made direct requests for specific information, this was supplied. Given the potential unreliability in assessment of developmental age, and undue weight which may be attached to its significance, parents were not routinely informed of the results obtained by their child. However, parents were asked for their opinions on their child's performance and the purpose of the developmental assessment was discussed.

A letter giving written details of the purpose of the experiment and an outline of the results was sent to each parent that participated for each study. A reply form and freepost envelope was included for parents to indicate that they did not wish to be contacted for participation in further experiments. Of 91 participants in the empirical studies, only two refusals were received, on each occasion detailing personal reasons for not wishing to participate.

Further debriefing was provided in the form of a regular newsletter to all those who participated in the empirical studies and to interested professionals. The newsletter gave general details of the research project and contact details where parents could obtain more information.

In debriefing, and indeed throughout contact with parents and children, particular attention was paid to BPS guidelines on the giving of advice. It is likely that parents of children with Down's Syndrome may be particularly sensitive to advice, however well meaning, and this may be given undue significance or treated as implicit criticism. Given the limited scope of the current work with children, and the concurrent involvement of qualified clinicians, advice was not routinely offered. Our experimental studies are concerned with the potential implications for intervention. However, at this stage such implications are speculative at best and cannot therefore form the basis for routine advice to parents.

A.4 Summary

The ethical procedures adopted in this study comply with the guidelines proposed by the BPS (1991). Guidelines have been considered with particular reference to children with Down's Syndrome and to their parents. This group may be particularly vulnerable where issues of consent, coercion and debriefing are concerned.

Appendix B

Uzgiris & Hunt Scales

B.1 Means - ends Scale

4. Letting go of an object in order to reach for another.

8. Use of string horizontally to obtain an object.

9. Use of a string vertically to obtain an object.

10. Use of a stick to obtain an object.

11. Placing a necklace in a bottle.

12. Stacking a set of rings avoiding one solid ring.

B.2 Object concept Scale

4. Finding an object which is completely covered.

8. Finding an object after successive visible displacements (3 screens A,B & C).

(Reverse order of hiding between trials & switch screens around)

10. Finding an object following one invisible displacement.

(Object in container, container under A, container removed leaving object under cloth.)

13. Finding an object following one invisible displacement with three covers.

(Object is hidden in container, container is placed under either A, B, or C; object is left under cover A, B, or C. Show empty container.

Child must search at correct cloth.)

14. Finding an object following a series of invisible displacements.

(Object hidden in hand, hand placed under A, then B, then C; object is left under C. Show empty hand. (no change of direction between trials).

Child must search directly under C.)

15. Finding an object following a series of invisible displacements by searching in reverse order of hiding.

(If correct search at C, 3 times on task 14, then repeat task 14 but leave object under A repeat task 14 once then task 15.

Child must search systematically from last screen back to the first (i.e. C>B>A))

Appendix C

Methodological issues: performance consistency of BSID II test items

Table C-1 and Table C-2 show details of items showing poor consistency (below 70%) for the DS and NDS groups respectively. Items identified as having poor consistency by Duffy (1990, p.86-87) are indicated for comparison.

Item Number	Description	DS	(N)	NDS	(N)
124	discriminates cube, key, book	58.3	10	41.7	11
133	names five pictures	58.3	7	83.3	11
85	Removes pellet from bottle	66.7	12	100.0	12
95	Puts nine cubes in cup	66.7*	12	91.7	12
114	uses 2-word utterance	66.7	12	75.0	11
116	discriminates scribble from stroke	66.7*	10	58.3	11
125 +	matches pictures	66.7	10	66.7	11
141	understands concept of one	66.7*	6	91.7	7

*Table C-1 Items showing poor consistency in DS Group. (+ Item introduced in Bayley Scales Version II, * Item identified as showing poor consistency by Duffy, 1990)*

Item Number	Description	NDS	(N)	DS	(N)
124	Discriminates Book, Cube, and Key	41.7	11	58.3	10
118 +	identifies object in photo	50.0	11	91.7	10
123	build tower of six cubes	50.0	11	91.7	10
132 +	puts beads in tube	50.0	11	75.0	8
116	Differentiates Scribble from Stroke	58.3	11	66.7	10
129 +	makes contingent utterance	58.3	11	75.0	10
120	completes reversed pink board	66.7	11	91.7	10
125 +	Matches Pictures	66.7	11	66.7	10
131 +	Attends to Story	66.7	11	75.0	9
134 +	displays verbal comprehension	66.7	11	75.0	8
139	imitates horizontal and vertical strokes	66.7	7	75.0	6

*Table C-2 Items showing poor consistency in NDS Group. (+ Item introduced in Bayley Scales Version II, * Item identified as showing poor consistency by Duffy, 1990)*

Table C-3 and Table C-4 show details of items showing good consistency (over 90%) for the DS and NDS groups respectively. Items identified as having poor consistency by Duffy (1990, p.86-87) are indicated for comparison.

Item Number	Description	DS	(N)	NDS	(N)
80	Removes Lid from Box	100.0*	9	100.0	8
98	Places Pegs in 70 seconds	100.0	12	83.3	12
101	Shows Shoes, Other Clothing, or Object	100.0*	12	83.3	12
119	Places Pegs in 25 seconds	100.0*	10	75.0	11
137 +	Matches Four Colours	100.0	6	83.3	7
142 +	Produces Multiple-Word Utterances in Response to Picture Book	100.0	5	83.3	7
143 +	Recalls Geometric Forms	100.0	5	91.7	7
144 +	Discriminates Pictures	100.0	5	91.7	7
146 +	Counts (Number Names)	100.0	5	91.7	6
148 +	Uses Past Tense	100.0	5	100.0	5

*Table C-3 Items showing good consistency in DS Group. (+ Item introduced in Bayley Scales Version II, * Item identified as showing poor consistency by Duffy, 1990)*

Item Number	Description	NDS	(N)	DS	(N)
88 +	Retrieves Toy (Clear Box I)	100.0	12	75.0	12
148 +	Uses Past Tense	100.0	5	100.0	5
78	Vocalises Four Different Vowel-Consonant Combinations	100.0	12	83.3	12
79	Fingers Holes in Pegboard	100.0	12	83.3	12
80	Removes Lid from Box	100.0	12	100.0	12
81	Responds to Spoken Request	100.0	12	91.7	12
85	Removes Pellet from Bottle	100.0	12	66.7	12
86	Puts Three Cubes in Cup	100.0	12	83.3	12
87	Places one Peg Repeatedly	100.0	12	83.3	12
89	Puts Six Beads in Box	100.0	12	83.3	12
90	Places one Piece in Blues Board	100.0	12	83.3	12
92	Closes Round Container	100.0	12	83.3	12
100	Uses Two Different Words Appropriately	100.0	12	75.0	12
135	Builds Tower of Eight Cubes	100.0	11	91.7	8

*Table C-4 Items showing good consistency NDS Group. (+ Item introduced in Bayley Scales Version II, * Item identified as showing poor consistency by Duffy, 1990)*

Table C-5 details the stability of items identified as unstable by Duffy (1990). A number of items show wide variability in stability levels between our data and the stability levels found by Duffy. Data presented in this table and in Table C-3 and Table C-4 suggest only limited concordance in items identified as unstable by Duffy and those items identified in our present study.

Item Number	Description	DS	NDS	Duffy (1990) DS
104	Uses Rod to Attain Toy†	-	-	16.6
101	Shows Shoe, Other Clothing, or Object	100.0	83.3	29.0
89	Puts Six Beads in Box	83.3	100.0	40.0
92	Closes Round Container	83.3	100.0	43.0
103	Imitates Crayon Stroke	75.0	83.3	43.0
87	Places one Peg Repeatedly	83.3	100.0	50.0
96	Finds Toy under Reversed Cups	75.0	91.7	50.0
97	Builds Tower of Two Cubes	91.7	83.3	50.0
120	Completes Reversed Pink Board	91.7	66.7	50.0
123	Builds Tower of Six Cubes	91.7	50.0	50.0
141	Understands Concept of One	66.7	91.67	50.0
83	Pats Toy in Imitation	91.7	83.3	57.0
95	Puts Nine Cubes in Cup	66.7	91.7	57.0
91	Scribbles Spontaneously	91.7	91.7	60.0
94	Imitates Word	75.0	83.3	60.0
80	Removes Lid from Box	100.0	100.0	66.6
100	Uses Two Different Words Appropriately	75.0	100.0	66.6
116	Differentiates Scribble from Stroke	66.67	58.33	66.6
119	Places Pegs in 25 seconds	100.0	75.0	66.6
135	Builds Tower of Eight Cubes	91.7	100.0	66.6

Table C-5: Items Identified as Showing Poor Consistency by Duffy (1990) with corresponding consistency measures from the present study.

† Item 104 was omitted from all testing sessions as pilot testing showed the item to be unreliable. This item appears to require a table or some means of preventing a direct reach for the toy. Given that testing took place in children's homes and in a variety of different cicumstances, it was thought appropriate to omit this item.

Appendix D

Motor Development Questionnaire

Peter Smith   dob: 01.01.95

When did Peter first begin to walk (taking 2-3 steps without support)?

Age in months(if known):	
Date if known:	

When did Peter begin 'cruising' (walking around using furniture for support)?

Age in months (if known):	
Date if known:	

When did Peter first begin to crawl (on hands and knees)?

Age in months (if known):	
Date if known:	

When did Peter first begin to crawl (belly crawling)?

Age in months (if known):	
Date if known:	

Did Peter use a babywalker?

Yes   No

If yes, for how long?

Did Peter have any Physiotherapy?

Yes   No

If yes, for how long?

Appendix E

Analysis of Variance Tables from Studies

E.1 Chapter 8

E.1.1.1 p.149 Regressions & improvements x group

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	156.79	22	7.13		
GROUP	.02	1	.02	.00	.957

Tests involving 'REGIMP' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	246.96	22	11.23		
REGIMP	88.02	1	88.02	7.84	.010
GROUP BY REGIMP	2.52	1	2.52	.22	.640

- -

E.1.1.2 p.141 Bayley Scales: group x session

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	12601.79	22	572.81		
GROUP	379.69	1	379.69	.66	.424

Tests involving 'SESSION' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	420.46	22	19.11		
SESSION	77.52	1	77.52	4.06	.056
GROUP BY SESSION	7.52	1	7.52	.39	.537

- -

E.1.1.3 p.154 Bayley regressions x quartile

Tests of Significance for REGS using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	72.01	132	.55		
QUART	8.73	3	2.91	5.34	.002
GP	.56	1	.56	1.03	.313
QUART BY GP	9.59	3	3.20	5.86	.001
(Model)	18.73	7	2.68	4.91	.000
(Total)	90.74	139	.65		

R-Squared = .206
Adjusted R-Squared = .164

E.1.1.4 p.156 BRS x group (3 analyses)

Tests of Significance for TOEF using SEQUENTIAL Sums of Squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	17.70	5	3.54		
GROUP	25.07	1	25.07	7.08	.045
SESSION	26.14	5	5.23	1.48	.340
GROUP * SESSION	63.08	5	12.62	3.56	.095
NAME WITHIN GROU P * SESSION	1448.93	120	12.07	3.41	.084
(Model)	1563.22	131	11.93	3.37	.086
(Total)	1580.92	136	11.62		

R-Squared = .989
Adjusted R-Squared = .695

Tests of Significance for TERF using SEQUENTIAL Sums of Squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	60.80	5	12.16		
GROUP	36.10	1	36.10	2.97	.146
SESSION	111.66	5	22.33	1.84	.260
GROUP * SESSION	550.89	5	110.18	9.06	.015
NAMENUM5 WITHIN GROU P * SESSION	7528.43	120	62.74	5.16	.036
(Model)	8227.07	131	62.80	5.16	.035
(Total)	8287.87	136	60.94		

R-Squared = .993
Adjusted R-Squared = .800

Tests of Significance for TRS using SEQUENTIAL Sums of Squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	125.70	5	25.14		
GROUP	1.00	1	1.00	.04	.850
SESSION	190.33	5	38.07	1.51	.330
GROUP * SESSION	927.52	5	185.50	7.38	.023
NAME WITHIN GROUP * SESSION	11726.91	120	97.72	3.89	.065
(Model)	12845.76	131	98.06	3.90	.064
(Total)	12971.46	136	95.38		

R-Squared = .990
Adjusted R-Squared = .736

E.1.1.5 p.152 OP Regressions x Group

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	.005	1	.005	.186	.670
GROUP	.005	1	.005	.186	.670
Explained	.005	1	.005	.186	.670
Residual	.603	22	.027		
Total	.608	23	.026		

E.1.1.6 p.152 ME Regressions x Group

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	.002	1	.002	.178	.677
GROUP	.002	1	.002	.178	.677
Explained	.002	1	.002	.178	.677
Residual	.265	22	.012		
Total	.267	23	.012		

E.2 Chapter 9:

E.2.1 Study 1

E.2.1.1 p.176 Partial correlations: regression analysis

	Locomotor Experience	Chronological Age	Developmental Age	OP Score
Locomotor Experience	-	R^2= 0.93 F(1,14)=197.4 **	R^2=0.19 F(1,14)=3.19	R^2 = 0.40 F(1,14)=9.23 **
Chronological Age	R^2= 0.76 F(1,5)=1.53	-	R^2 =0.68 F(1,14)=30.92	R^2 = 0.37 F(1,14)=8.60*
Developmental Age	R^2 = 0.28 F(1,5)=12.8*	R^2 = 0.67 F(1,5)=10.1	-	R^2 = 0.36 F(1,14)=7.94*
OP Score	R^2 = 0.04 F(1,5)=0.20	R^2 =0.06 F(1,5)=0.137	R^2 = 0.20 F(1,5)=0.12	-

Table E-6: Regression coefficients and F Ratios analysis of variance(shaded: 37 observations, unshaded: 17 observations)

E.2.1.2 p.177 Regression analyses for whole group (n=37)

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	250.570	1	250.570	30.922	.000
DA	250.570	1	250.570	30.922	.000
Main Effects	565.706	21	26.938	3.324	.012
NAME	565.706	21	26.938	3.324	.012
Explained	2858.880	22	129.949	16.037	.000
Residual	113.445	14	8.103		
Total	2972.325	36	82.565		

```
        OP_SC
   by   NAME
   with DA

        UNIQUE sums of squares
        All effects entered simultaneously
```

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	7.300	1	7.300	7.944	.014
DA	7.300	1	7.300	7.944	.014
Main Effects	29.394	21	1.400	1.523	.211
NAME	29.394	21	1.400	1.523	.211
Explained	96.377	22	4.381	4.767	.002
Residual	12.866	14	.919		
Total	109.243	36	3.035		

```
        OP_SC
   by   NAME
   with AGE

        UNIQUE sums of squares
        All effects entered simultaneously
```

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	7.674	1	7.674	8.601	.011
AGE	7.674	1	7.674	8.601	.011
Main Effects	34.451	21	1.641	1.839	.122
NAME	34.451	21	1.641	1.839	.122
Explained	96.751	22	4.398	4.929	.002
Residual	12.492	14	.892		
Total	109.243	36	3.035		

E.2.1.3 p.177 Regression analyses for non-locomotor group (n=17)

```
     OP_SC
by   NAME
with AGE
```

UNIQUE sums of squares
All effects entered simultaneously

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	.080	1	.080	.137	.727
AGE	.080	1	.080	.137	.727
Main Effects	9.581	10	.958	1.641	.305
NAME	9.581	10	.958	1.641	.305
Explained	13.550	11	1.232	2.109	.212
Residual	2.920	5	.584		
Total	16.471	16	1.029		

```
     OP_SC
by   NAME
with DA
```

UNIQUE sums of squares
All effects entered simultaneously

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	.123	1	.123	.213	.664
DA	.123	1	.123	.213	.664
Main Effects	10.990	10	1.099	1.910	.246
NAME	10.990	10	1.099	1.910	.246
Explained	13.593	11	1.236	2.147	.206
Residual	2.877	5	.575		
Total	16.471	16	1.029		

```
        AGE
by      NAME
with    DA

        UNIQUE sums of squares
        All effects entered simultaneously
```

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Covariates	34.264	1	34.264	10.108	.025
DA	34.264	1	34.264	10.108	.025
Main Effects	127.512	10	12.751	3.762	.078
NAME	127.512	10	12.751	3.762	.078
Explained	478.171	11	43.470	12.824	.006
Residual	16.949	5	3.390		
Total	495.120	16	30.945		

17 cases were processed.
0 cases (.0 pct) were missing.

E.3 Chapter 10:

E.3.1 Study 2

E.3.1.1 p.195 Action word comprehension: group x stage

Tests of Significance for DA using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	235.75	20	11.79		
GROUP	1.49	1	1.49	.13	.726
STAGEC_1	255.27	1	255.27	21.66	.000
GROUP BY STAGEC_1	11.63	1	11.63	.99	.332
(Model)	273.59	3	91.20	7.74	.001
(Total)	509.33	23	22.14		

R-Squared = .537
Adjusted R-Squared = .468

E.3.1.2 p.196 Action word comprehension: group x word x session

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	53.44	22	2.43		
GROUP	.03	1	.03	.01	.911

Tests involving 'SESS' Within-Subject Effect.

AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	50.85	110	.46		
SESS	4.03	5	.81	1.74	.131
GROUP BY SESS	2.36	5	.47	1.02	.408

Tests involving 'WORDTYP' Within-Subject Effect.

Tests of Significance for T7 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	15.16	22	.69		
WORDTYP	.00	1	.00	.01	.944
GROUP BY WORDTYP	.42	1	.42	.61	.443

Tests involving 'SESS BY WORDTYP' Within-Subject Effect.

AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	28.97	110	.26		
SESS BY WORDTYP	1.73	5	.35	1.31	.265
GROUP BY SESS BY WOR DTYP	.23	5	.05	.17	.973

E.3.1.3 p.197 Action word comprehension: group x wordtype x op stage x session

Tests of Between-Subjects Effects.

Tests of Significance for T1 using SEQUENTIAL Sums of Squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	40.55	21	1.93		
STAGECON	12.69	1	12.69	6.57	.018
GROUP	.23	1	.23	.12	.735

Tests involving 'WORDTYP' Within-Subject Effect.

Tests of Significance for T2 using SEQUENTIAL Sums of Squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	13.77	21	.66		
WORDTYP	.00	1	.00	.01	.943
STAGECON BY WORDTYP	1.25	1	1.25	1.91	.182
GROUP BY WORDTYP	.55	1	.55	.84	.369

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E.3.1.4 p.199 Action word comprehension: Tomasello & Farrar comparison analysis

* * * * * * A n a l y s i s   o f   V a r i a n c e -- design 1 * *

Tests of Significance for MEAN using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	4.24	23	0.26		
STAGE	8.90	1	8.90	48.40	**
STUDY	1.28	1	1.28	6.90	*
WORD_TYP	3.18	2	1.59	8.60	**
STAGE BY STUDY	1.23	1	1.23	25.70	**
STAGE BY WORD_TYP	.46	2	.23	1.25	NS
STUDY BY WORD_TYP	.13	2	.07	0.38	NS
STAGE BY STUDY BY WO RD_TYP	.34	2	.17	0.92	NS

E.3.1.5 p.203 Action word production: wordtype x stage x group x session

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	25.11	20	1.26		
GROUP	2.45	1	2.45	1.95	.177
STAGECON	3.16	1	3.16	2.51	.128
GROUP BY STAGECON	.84	1	.84	.67	.424
GROUP BY STAGECON	.032	.666	.151		

Tests involving 'SES' Within-Subject Effect.

AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	40.24	100	.40		
SES	1.35	5	.27	.67	.645
GROUP BY SES	2.21	5	.44	1.10	.365
STAGECON BY SES	2.41	5	.48	1.20	.317
GROUP BY STAGECON BY SES	2.81	5	.56	1.40	.231

Tests involving 'WORD' Within-Subject Effect.

Tests of Significance for T7 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	25.98	20	1.30		
WORD	.56	1	.56	.43	.518
GROUP BY WORD	.59	1	.59	.46	.507
STAGECON BY WORD	.05	1	.05	.04	.841
GROUP BY STAGECON BY WORD	1.11	1	1.11	.86	.366

Tests involving 'SES BY WORD' Within-Subject Effect.

AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	41.98	100	.42		
SES BY WORD	1.74	5	.35	.83	.531
GROUP BY SES BY WORD	1.60	5	.32	.76	.580
STAGECON BY SES BY W ORD	1.56	5	.31	.74	.593
GROUP BY STAGECON BY SES BY WORD	1.77	5	.35	.84	.522

E.3.1.6 p.205 Action word comprehension: group x stage-stability x wordtype

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	5.22	16	.33		
GROUP	.15	1	.15	.46	.510
STAGECAT	3.29	3	1.10	3.36	.045
GROUP BY STAGECAT	.21	3	.07	.22	.883

Tests involving 'WORDTYPE' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	2.27	16	.14		
WORDTYPE	.00	1	.00	.01	.926
GROUP BY WORDTYPE	.06	1	.06	.45	.512
STAGECAT BY WORDTYPE	.13	3	.04	.30	.825
GROUP BY STAGECAT BY WORDTYPE	.13	3	.04	.30	.825

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E.3.1.7 p.210 Object word comprehension scores: group x stagex session

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	17.42	20	.87		
GROUP	2.38	1	2.38	2.74	.114
STAGECON	3.04	1	3.04	3.49	.077
GROUP BY STAGECON	.34	1	.34	.39	.539

Tests involving 'SESS' Within-Subject Effect.

AVERAGED Tests of Significance for OBRT using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	70.59	100	.71		
SESS	2.54	5	.51	.72	.611
GROUP BY SESS	.82	5	.16	.23	.948
STAGECON BY SESS	2.00	5	.40	.57	.726
GROUP BY STAGECON BY SESS	.58	5	.12	.16	.975

E.3.1.8 p.211 Elicited production of object words: group x stage x session

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	21.23	20	1.06		
GROUP	5.60	1	5.60	5.28	.033
STAGECON	3.75	1	3.75	3.53	.075
GROUP BY STAGECON	.30	1	.30	.28	.602

Effect Size Measures and Observed Power at the .0500 Level

Source of Variation	Partial ETA Sqd	Noncen-trality	Power
GROUP	.209	5.276	.587
STAGECON	.150	3.532	.432
GROUP BY STAGECON	.014	.281	.063

Tests involving 'SES' Within-Subject Effect.

AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	21.27	100	.21		
SES	2.26	5	.45	2.13	.068
GROUP BY SES	1.90	5	.38	1.79	.122
STAGECON BY SES	1.42	5	.28	1.33	.256
GROUP BY STAGECON BY SES	2.31	5	.46	2.17	.064

E.3.1.9 p.212 Spontaneous production of object words: group x stage

Source of Variation	Sum of Squares	DF	Mean Square	F	Sig of F
Main Effects	27.594	2	13.797	3.456	.051
GROUP_1	5.316	1	5.316	1.332	.262
STAGEC_1	20.324	1	20.324	5.091	.035
2-Way Interactions	.024	1	.024	.006	.940
GROUP_1 STAGEC_1	.024	1	.024	.006	.940
Explained	27.594	3	9.198	2.304	.108
Residual	79.840	20	3.992		
Total	107.434	23	4.671		

E.3.1.10 p.212 MacArthur CDI scores : group x stage

Tests of Significance for COMP using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	72398.68	20	3619.93		
GROUP_1	20315.22	1	20315.22	5.61	.028
STAGEC_1	21392.22	1	21392.22	5.91	.025
GROUP_1 BY STAGEC_1	1994.98	1	1994.98	.55	.466
(Model)	46701.94	3	15567.31	4.30	.017
(Total)	119100.62	23	5178.29		

R-Squared = .392
Adjusted R-Squared = .301

Tests of Significance for PROD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	89329.06	20	4466.45		
GROUP_1	20019.16	1	20019.16	4.48	.047
STAGEC_1	53808.29	1	53808.29	12.05	.002
GROUP_1 BY STAGEC_1	12224.77	1	12224.77	2.74	.114
(Model)	90081.44	3	30027.15	6.72	.003
(Total)	179410.50	23	7800.46		

R-Squared = .502
Adjusted R-Squared = .427

Tests of Significance for COMP using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	55271.02	19	2909.00		
REGRESSION	17127.66	1	17127.66	5.89	.025
GROUP_1	14942.87	1	14942.87	5.14	.035
STAGEC_1	29.04	1	29.04	.01	.921
GROUP_1 BY STAGEC_1	5609.28	1	5609.28	1.93	.181
(Model)	63829.61	4	15957.40	5.49	.004
(Total)	119100.62	23	5178.29		

R-Squared = .536
Adjusted R-Squared = .438

Regression analysis for WITHIN+RESIDUAL error term
--- Individual Univariate .9500 confidence intervals
Dependent variable .. COMP

COVARIATE	B	Beta	Std. Err.	t-Value	Sig. of t
BAYLEY_1	2.43048	.56739	1.002	2.426	.025

COVARIATE	Lower -95%	CL- Upper
BAYLEY_1	.334	4.527

Tests of Significance for PROD using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	67982.86	19	3578.05		
REGRESSION	21346.20	1	21346.20	5.97	.025
GROUP_1	14165.85	1	14165.85	3.96	.061
STAGEC_1	2830.59	1	2830.59	.79	.385
GROUP_1 BY STAGEC_1	20313.01	1	20313.01	5.68	.028
(Model)	111427.64	4	27856.91	7.79	.001
(Total)	179410.50	23	7800.46		

R-Squared = .621
Adjusted R-Squared = .541

Regression analysis for WITHIN+RESIDUAL error term
--- Individual Univariate .9500 confidence intervals
Dependent variable .. PROD

COVARIATE	B	Beta	Std. Err.	t-Value	Sig. of t
BAYLEY_1	2.71334	.51609	1.111	2.443	.025

COVARIATE	Lower -95%	CL- Upper
BAYLEY_1	.388	5.038

E.4 Chapter 11

E.4.1 Study 3

E.4.1.1 p.236 Condition x order x group

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	1696.67	32	53.02		
GROUP	44.81	1	44.81	.85	.365
ORDER	41.41	1	41.41	.78	.383
GROUP BY ORDER	19.13	1	19.13	.36	.552

- -

Tests involving 'OP_IMIT' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	447.24	32	13.98		
OP_IMIT	309.01	1	309.01	22.11	.000
GROUP BY OP_IMIT	60.81	1	60.81	4.35	.045
ORDER BY OP_IMIT	4.79	1	4.79	.34	.562
GROUP BY ORDER BY OP _IMIT	1.56	1	1.56	.11	.741

E.4.1.2 p.238 Condition x order x group (proportion scores)

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	1.10	31	.04		
REGRESSION	2.26	1	2.26	63.95	.000
GROUP__2	.08	1	.08	2.16	.152
ORDER__2	.00	1	.00	.06	.805
GROUP__2 BY ORDER__2	.06	1	.06	1.60	.215

Tests involving 'OP_IMIT' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	.98	32	.03		
OP_IMIT	.80	1	.80	25.99	.000
GROUP__2 BY OP_IMIT	.16	1	.16	5.18	.030
ORDER__2 BY OP_IMIT	.00	1	.00	.06	.808
GROUP__2 BY ORDER__2 BY OP_IMIT	.00	1	.00	.08	.773

E.4.1.3 p.240 Response times: group x response x condition

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	85.23	23	3.71		
GROUP	.25	1	.25	.07	.799

Tests involving 'CON' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	62.86	23	2.73		
CON	1.04	1	1.04	.38	.543
GROUP BY CON	.63	1	.63	.23	.635

Tests involving 'CORR' Within-Subject Effect.

Tests of Significance for T3 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	36.09	23	1.57		
CORR	2.87	1	2.87	1.83	.189
GROUP BY CORR	.70	1	.70	.45	.510

- -

Tests involving 'CON BY CORR' Within-Subject Effect.

Tests of Significance for T4 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	25.45	23	1.11		
CON BY CORR	.09	1	.09	.09	.772
GROUP BY CON BY CORR	.64	1	.64	.58	.455

E.4.1.4 p.241 Error x condition x group

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	.00	65	.00		
GROUP_1	.00	1	.00	.	.
COND	.00	1	.00	.	.
GROUP_1 BY COND	.00	1	.00	.	.

\- -

Tests involving 'ERRORTYP' Within-Subject Effect.

AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	190093.19	130	1462.26		
ERRORTYP	33344.43	2	16672.21	11.40	.000
GROUP_1 BY ERRORTYP	9534.94	2	4767.47	3.26	.042
COND BY ERRORTYP	7228.02	2	3614.01	2.47	.088
GROUP_1 BY COND BY E RRORTYP	1702.51	2	851.25	.58	.560

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E.4.2 Study 4

E.4.2.1 p.249 Group x scale x order

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	557.25	23	24.23		
REGRESSION	939.84	1	939.84	38.79	.000
ORDER	95.49	5	19.10	.79	.569
GROUP	.54	1	.54	.02	.882
ORDER BY GROUP	56.62	5	11.32	.47	.796

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Regression analysis for WITHIN+RESIDUAL error term
--- Individual Univariate .9500 confidence intervals
Dependent variable .. T1

COVARIATE	B	Beta	Std. Err.	t-Value	Sig. of t	Lower -95%
TDA	.83346	.80836	.134	6.228	.000	.557

COVARIATE	CL- Upper
TDA	1.110

Tests involving 'SCALE' Within-Subject Effect.

AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	509.18	48	10.61		
SCALE	279.62	2	139.81	13.18	.000
ORDER BY SCALE	80.66	10	8.07	.76	.665
GROUP BY SCALE	103.23	2	51.61	4.87	.012
ORDER BY GROUP BY SC ALE	93.87	10	9.39	.88	.553

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E.5 Chapter 12:

E.5.1 Study 5

E.5.1.1 p.266 Pilot testing data: target x condition

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	71.24	23	3.10		
CONSTANT	297.51	1	297.51	96.05	.000

Tests involving 'MODEL' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	40.16	23	1.75		
MODEL	4.59	1	4.59	2.63	.118

Tests involving 'PLAYTPE' Within-Subject Effect.

Tests of Significance for T3 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	150.74	23	6.55		
PLAYTPE	.01	1	.01	.00	.969

Tests involving 'MODEL BY PLAYTPE' Within-Subject Effect.

Tests of Significance for T4 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	66.24	23	2.88		
MODEL BY PLAYTPE	52.51	1	52.51	18.23	.000

E.5.1.2 p.269 Target directed play: target x group x condition

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	160.85	34	4.73		
GROUP	15.34	1	15.34	3.24	.081

Tests involving 'COND' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	33.01	34	.97		
COND	3.67	1	3.67	3.78	.060
GROUP BY COND	.06	1	.06	.06	.801

Tests involving 'TARGET' Within-Subject Effect.

Tests of Significance for T3 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	217.74	34	6.40		
TARGET	91.84	1	91.84	14.34	.001
GROUP BY TARGET	1.17	1	1.17	.18	.671

Tests involving 'COND BY TARGET' Within-Subject Effect.

Tests of Significance for T4 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	161.01	34	4.74		
COND BY TARGET	297.56	1	297.56	62.83	.000
GROUP BY COND BY TAR GET	24.17	1	24.17	5.10	.030

E.5.1.3 p.274 Second & subsequent acts group x target x condition

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	197.06	34	5.80		
GROUP	28.44	1	28.44	4.91	.034

Tests involving 'TARGET' Within-Subject Effect.

Tests of Significance for T2 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	225.78	34	6.64		
TARGET	124.69	1	124.69	18.78	.000
GROUP BY TARGET	.03	1	.03	.00	.949

Tests involving 'CONDITIO' Within-Subject Effect.

Tests of Significance for T3 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	44.11	34	1.30		
CONDITIO	1.36	1	1.36	1.05	.313
GROUP BY CONDITIO	.03	1	.03	.02	.885

Tests involving 'TARGET BY CONDITIO' Within-Subject Effect.

Tests of Significance for T4 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	139.94	34	4.12		
TARGET BY CONDITIO	266.78	1	266.78	64.81	.000
GROUP BY TARGET BY C ONDITIO	18.78	1	18.78	4.56	.040

E.5.1.4 p.273 Target swaps: group x shift-type

Tests of Between-Subjects Effects.

Tests of Significance for T1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	69.33	34	2.04		
GROUP	5.33	1	5.33	2.62	.115

Tests involving 'SWAP' Within-Subject Effect.

AVERAGED Tests of Significance for MEAS.1 using UNIQUE sums of squares

Source of Variation	SS	DF	MS	F	Sig of F
WITHIN+RESIDUAL	325.78	68	4.79		
SWAP	7.06	2	3.53	.74	.483
GROUP BY SWAP	18.50	2	9.25	1.93	.153