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DEVELOPMENT IN DOWN SYNDROME AND NORMAL INFANTS: ATTENTION, EXPLORATION AND ENVIRONMENTAL RESPONSIVITY

by

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ABSTRACT

This study investigated the responsiveness of the young Down syndrome child's home environment and the ability of these infants to focus attention on and engage in refined exploration of novel toys.

Fifteen Down syndrome children between the ages of 11 and 15 months were individually matched to three groups of normally developing children on the basis of each child's scores on the Bayley Scales of Infant Development (Bayley, 1969). The four groups were a Down syndrome group, a mental-age-matched group, a motor-age-matched group, and a chronological-age-matched group. Each caregiver completed a Toy Responsivity Scale that examined the number of responsive toys in the home and an Infant Intentionality Questionnaire that measured the caregiver's perception of his or her child's intentional behavior. Each child-caregiver pair was videotaped in a sixteen minute teaching/play episode. Videotapes were subsequently scored for four types of child attention behaviours (offtask, social, vision alone, and vision with manipulation), four types of child exploration behaviours (focused examination, simple exploration, complex exploration, and task mastery), and one caregiver behaviour (responsivity).

Down syndrome children differed from normally developing children in their attentional behavior, in their explorational behavior, and in their caregivers' responses to the Infant

Intentionality Questionnaire. They did not differ on the Toy Responsivity Scale or in caregiver responsivity. When compared to all three groups of normally developing children, the Down syndrome children spent significantly less time offtask, less time in focused examination, and more time in vision alone. They also spent less time in complex exploration and more time in simple exploration than did normal children of similar chronological age, but they were not significantly different from mental- and motor-age-matched children in these behaviors.

Prolonged visual fixations without focused examination or offtask monitoring suggest that Down syndrome children may have significant problems in information intake that could severely reduce their ability to learn from an information-rich environment. Possible directions for future research are discussed as well as specific suggestions for interventions with these children.

DEDICATION

To my family. Without their support, encouragement, and faith this thesis could never have been.

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CHAPTER I

INTRODUCTION

Our knowledge of the young infant's capabilities has steadily increased over the past decade. At one time the infant was believed to be a passive, nonreactive organism at the mercy of environmental events, but it is now clear that this is not so. The newborn infant is a highly competent organism capable of responding to stimuli in organized and meaningful ways. Infants enter the world with selected sensory and perceptual competencies, and with known behavioral propensities that guide development and allow the infant to benefit maximally from environmental input (Gibson & Spelke, 1983). What is still unknown is the extent to which biological insult to the organism, for example, Down syndrome, modifies these inborn abilities and propensities. In addition, the extent to which Down syndrome changes the nature of infant behavior and the course of future development is also unknown.

The changes occurring within the first year of life are some of the most dramatic of the entire human lifespan. The most profound transformations are not those involving the enhancement of sensory capacity or the refinement of motor function, although these also occur at this time, but are those involving the infant's ability to make sense of the world, to attribute meaning to what is perceived, and to act on the information coming through the senses. These changes in the infant's ability to take in information through the senses and to attribute meaning to that information are central to the study of perceptual-cognitive development.

There is a strong intrinsic motivation in the normally developing child to attend to the people and objects in his or her environment, to explore them in order to learn their distinctive properties, and to attempt to influence their actions and have an impact on them (Hunt, 1963; 1965; White, 1959). This intrinsic motivation to assimilate, to learn about, and to master the environment can be seen initially in the neonate's orientation to objects and visual inspection of them. As the infant's behavioral repertoire improves with increasing age, tactile exploration is added as another, more developmentally advanced, means for obtaining information from the environment (Yarrow & Messer, 1983). These developing skills, in turn, lead the infant into active attempts to have an impact on the environment and to secure contingent feedback from objects and people. Developmental theorists have argued that it is the young infant's visual and manual exploration of the environment that constitutes the most important learning experience in the first two years of life (Bruner, 1973; Piaget, 1952; White, 1959).

Normal infant development is characterized by a linear relation between skill progression and age. In contrast, the Down syndrome child's developmental progress is characterized by a curvilinear relationship between age and developing skill, as measured by the Gesell developmental quotient (Carr, 1970; Dicks-Mireaux, 1972). There appears to be a steep decline in the Down syndrome child's developmental quotient between the ages of four and ten months and then a more gradually deceleration until two years. It is possible that this developmental decline may be due to differences in early attentional and explorational skills that make the Down syndrome child less efficient than the normally developing child in learning from an information-rich environment.

The infant born with a handicap may not show the same motivation, the same propensities or the same range of early skills as does the normally developing child. Even if the same propensities and skills do unfold, there may be differences in the timing of their developmental emergence or an inability on the infant's part to use them to their full advantage to promote early learning. Since these early skills form much of the foundation for subsequent development, deficits in one or more areas can have a substantial impact on future growth.

The aim of the present research is to investigate the manner in which a handicap, such as Down syndrome, can influence early growth and affect later development. The specific focus will be on early perceptual-cognitive development, in particular the 12-month-old Down syndrome infant's ability to focus attention on and engage in refined exploration of novel objects. Ability in both these areas is intimately tied to inborn propensities and newborn skills in the normally developing child, while at the same time being modifiable by early environmental experience. Furthermore, the infant's skill in attention and in exploration affects current cognitive functioning and has a substantial impact on the course of later cognitive and intellectual development (Yarrow & Messer, 1983).

To understand the impact of a handicapping condition, it is necessary to understand the foundations on which behavior is based and the processes that influence its development. The following sections briefly review perceptual-cognitive growth in the normally developing child by focusing on early perceptual, motor, cognitive and memory abilities in these children, as well as on the role that the child's early home environment can play in the development of these skills. A more detailed overview of research pertaining to the development of attentional and exploratory skills in the child with Down syndrome is then provided. Following these empirical reviews, a description of and rationale for this investigation is provided.

Normal Perceptual-Cognitive Development

There is a large body of research indicating the functionality of the infant's auditory, visual, and tactile sensory systems. The labile and erratic nature of the newborn infant's states presents a major limitation both to the infant's information-processing capacity and to our knowledge of it; however, we do know that most sensory systems are remarkably well developed at birth. We also know that the infant comes already equipped with certain built in selection biases that direct attention to some of the more salient and important aspects of the environment. Thus, the newborn infant comes already equipped with many of the perceptual skills necessary for processing the information of the world.

Reliance on Visual Information: Birth to Six Months

One sensory system that is remarkably well developed at birth is the infant's visual system. Even newborn infants can selectively fixate the visual world. When an interesting high-contrast edge comes into the infant's visual field, the newborn will selectively fixate on the edge or contour, directing his/her gaze back and forth across this feature for prolonged periods of time (Haith, 1980; Kessen, Salapatek & Haith, 1972). However, at this young an age the quality of the visual information the infant receives does not approach that of the adult; visual acuity is poor and the infant appears to focus best at 19 centimeters (Fagan & Sheppard, 1982).

Newborn infants prefer to look at certain stimuli over others. In general, patterned stimuli are preferred to unpatterned ones, but some patterns elicit more attention than do others (Fagan & Sheppard, 1982). Preferences among patterns are mediated by variations along specific dimensions which include, but are not limited to, size, number of elements and form of contour (Fantz & Fagan, 1975; Karmel & Maisel, 1976;

Milewski, 1979). There is some evidence to indicate that these early preferences are manifestations of the infant's developing sensory abilities and the degree of cortical excitation generated by an individual stimulus (Olson & Strauss, 1984).

It is now well accepted that alert newborn infants not only fixate visual stimuli but are also capable of taking in this visual information, holding it in memory for short periods of time, and retrieving it for comparison with a new stimulus (Friedman, 1972a; 1972b, 1975; Friedman, Bruno and Vietze, 1974; Friedman and Carpenter, 1971; Friedman, Carpenter, and Nagy, 1970; Friedman, Nagy and Carpenter, 1970; Slater, Morrison & Rose, 1982). In addition, infants as young as one month of age can learn to make instrumental responses (e.g., nonnutritive sucking) if the presence or withdrawal of visual stimulation is made contingent upon the response (Siqueland & Delucia, 1969; Lipsitt & Werner, 1981). However, these early memories are short in duration and there are species-specific constraints so that only certain types of associations are easily learned (Sameroff & Cavanagh, 1979; Olson & Strauss, 1984). In many respects it appears that infants are "built" to organize and find structure in what might otherwise be a random and chaotic world (Fagan, Morrongiello, Rovee-Collier, & Gekov, 1984).

Within the first three months of life there is rapid maturation of the infant's nervous system so that by three months of age infant states have become better organized and the infant is alert for longer periods of time (Parmelee, 1974;

Parmelee & Stern, 1972). Rapid growth in the infant's ability to resolve pattern detail and improvements in the infant's scanning ability result in a greater pickup of pattern detail by the infant at this time (Fagan & Sheppard, 1982; Salapatek, 1975). The infant begins to show a strong visual preference for stimuli of increased complexity, for irregular patterns over regular ones, for patterns with high contour density over those with low, for concentric over nonconcentric stimuli, for symmetrical over nonsymmetrical stimuli, and for novel stimuli over familiar ones (Olson & Sherman, 1983). For years researchers have searched for some single underlying dimension such as "complexity" or "amount of contour" to explain these age related shifts, but these types of explanations have never proved adequate (Fantz & Fagan, 1975: Fagan & Sheppard, 1982).

By three months of age, a broad and diverse range of learning and memory skills become apparent. Habituation research employing an impressive diversity of stimuli and specific learning conditions consistently show learning on the part of the three month old (e.g., Barrera & Maurer, 1981; Bornstein, 1984; Caron, Caron & Carlson 1978; Cook, Fields & Griffiths, 1979; Milewski, 1979; Olson & Sherman, 1983; Ruff, 1984b; Young-Brown, Rosenveld & Horowitz, 1977). By this age, infants can easily be conditioned to associate their movements with a variety of visual and auditory events (Fagan & Rovee, 1976; Rovee & Rovee, 1969; Rovee-Collier, Sullivan, Enright, Lucas, & Fagan, 1980; Sullivan, Rovee-Collier & Tynes, 1979). Infants are able to extract some basic principle about responsivity from their experiences with responsive mobiles and can demonstrate this learning with discriminately different mobiles (Fagan, Morrongiello, Rovee-Collier & Gekov, 1984). This generalization is not based solely on the abstraction of invariant features across the succession of familiar mobiles since infants are also able to demonstrate memory of category-specific information (Hayne, Rovee-Collier & Ferris, 1987). Altogether, these studies demonstrate that the three month old is rapidly learning about the environment and about events and consequences in this environment.

In contrast to newborn infants' advanced perceptual abilities, their motor systems appear immature and incompetent. However, despite apparent immaturity and disorganization, a number of impressive and important competencies are evident in reflexive behavior. An example would be the orienting reflex, a motor response to stimulus change that directs the sensory receptors toward a source of novel stimulation, or the walking reflex that allows the infant to step when held upright and pulled forward across a hard surface (Thelen & Fischer, 1982). These newborn reflexes form the foundations for many of the infant's later cognitive and motor abilities (Easton, 1972; 1978; Thelen, Kelso & Fogel, 1987).

The reflexes that characterize the newborn period gradually disappear within the first weeks of life as they become changed and adapted into more focused, organized, and voluntary behaviors (Thelen et al, 1987). As these primitive reflexes loosen their control over motor behavior and become consolidated into higher-level movements, the infant gradually develops improved head, shoulder and arm control. This allows the infant to lift its head and turn in the direction of sounds, or to move its head from side to side to follow objects with its eyes. The infant's hands are tightly fisted throughout early life but as the extension process continues in cephalocaudal and proximodistal directions the infant develops more shoulder control, and eventually hand and finger control.

From 4 to 6 months the infant's central nervous system matures and primitive reflexes become modified. At this time the infant begins to bring his or her hands together at midline (e. g., when playing with clothes or exploring hands) and by 6 months this primitive clutching has become a palmar grasp. The infant can then make a two-handed reach toward midline to grasp a favorite toy (Trevarthen, 1982; Hofsten, 1982). At this time most infants are sitting well without support, leaving their hands free to make contact with and explore the immediate environment (Henderson, 1985).

In these first few months of life the infant has made few deliberate efforts to make contact with or bring about changes in the environment. The infant's main contact with objects has been through holding or mouthing. These behaviors provide some tactile information but are very inefficient for interacting with the world. By 4 to 6 months this begins to change and the infant progresses to a more active manipulation of objects. The infant's greater wrist mobility at this time allows him or her to move an object in either vertical or horizontal directions (Connor, Williamson & Siepp, 1978). The infant's behavior is now characterized by the indiscriminate application of a few available behaviors (e.g., banging and shaking) to a wide variety of objects. The infant appears to focus on the behavior with the object serving only as a means for the action (Piaget, 1952; Uzgiris, 1977; 1983).

The infant next begins to show some primitive evidence of trying to "make things happen". At first the infant capitalizes on events that occur spontaneously or accidentally (e.g., moving the rattle up and down against the crib produces noise) but rapidly learns to continue the action to make the interesting event reoccur (Brinker & Lewis, 1982). While the infant's predominant actions on objects still consist only of mouthing, looking, and banging, the child soon begins to repeat and modify these behaviors so as to reproduce interesting effects (Piaget, 1952). These actions are not coordinated in any way and attention is still directed primarily toward the action; objects have importance only insofar as they permit or hinder the flow of activity. Knowledge of object properties appears to be limited and the infant's repertoire of schemes is applied to objects indiscriminately.

Thus, in the first months of life the infant has a sophisticated sensory system that provides him or her with good quality visual information, while at the same time having an immature motor system that permits little tactile or haptic information gathering. In the early months, distal perception in the form of looking and listening is the infant's most important means for gaining information about the world (Butterworth, 1983). Research has amply demonstrated that in these early months infants are capable of taking in, processing and remembering visual information, and are capable of using this knowledge to guide subsequent visual exploration (Olson, 1981). As the child gains more control over the motor system, he or she also begins to show more interest in making physical contact with environmental objects. However, attention is still focused exclusively on the infant's own action and on the continuation of the interesting effect, with little interest shown in the utilized object. Inborn propensities may initiate the process but by six months of age new learning is increasingly dominated by the infant's current knowledge of the world, by knowledge about objects in general, and by knowledge about the characteristics of particular objects (Olson & Sherman, 1983).

Focused Attention and Manipulation: Six to Twelve Months

By six months of age the infant's learning and memory skills are robust and impressive. Infants now show the ability to remember on the basis of only a few seconds exposure (Olson, 1979) and longterm retention of learned information can be easily demonstrated (Fagan, 1973). The six month old infant also shows a broad range of specific encoding skills that involve the recognition of details in patterns and recognition of the subtler aspects of stimuli (Olson, 1976). Habituation is faster in older infants, in part, because they are more efficient information processers, but also because they have more experience with and knowledge of stimuli so that a particular stimulus is less likely to be completely novel to them. The storehouse of knowledge that has been gradually accumulated in the first months of life now begins to have a substantial impact on learning and on memory skills.

Young infants explore their environment primarily by looking and by mouthing. This changes in the latter half of the first year when visually guided manipulation becomes the predominant mode of exploration (McQuiston & Wachs, 1979; Hunter & Ames, in press). By 6 months of age the infant's basic motor skills have improved to the point where they can have a substantial impact on the infant's selective attention. The prehensive system is now under enough control to engage in exploratory behavior with a variety of three-dimensional objects. Whereas complexity and novelty have been important attention-getting dimensions, object responsivity now becomes an important additional variable (Wachs, 1976). The infant not only selectively fixates visual objects, but also selectively reaches for, grasps, mouths, and manipulates these objects. In fact, it is becoming extremely difficult to keep the infant's attention focused solely on visual targets; objects that can be both looked at and manipulated to produce a variety of visual, auditory or tactile changes have much greater attentional value (Ruff, 1985).

Focused examination is the form of visually guided manipulation that is most prominent at this age (Gibson & Spelke, 1983) and that is most frequently utilized as a index of the older infant's attention and information processing (Hunter & Ames, in press; Ruff, 1984a; Uzgiris, 1983). The appearance of focused examination represents a major turning point in the infant's experience with objects. During focused examination the infant holds the object in his/her hand, turning it around and manipulating its parts, while simultaneously observing the object and the effects of the manipulations on the object (Ruff, 1985). Visually-guided object manipulation, and in particular, focused examination, leads to a complex experience involving visual, tactile, and kinesthetic stimulation out of which emerges information about objects and their properties, and information about the infant's actions and their consequences (Ruff, 1984b).

All habituation studies revealing familarity preferences in children of this age have used three dimensional objects and haptic familiarization procedures (Hunter & Ames, in press). This is primarily because of the complex visual, tactile and kinesthetic experiences these stimli provide to the infant. At this age a strong preference for the familar stimulus continues until such time as the infant feels comfortable in having elicited and processed all the information contained in the stimulus (Hunter & Ames, in press). These familarity preferences have been recognized as just as valid and reliable an indicator of memory as have novelty preferences (Rose, Gottfried, Melloy-Carminar, & Bridger, 1982; Wagner & Sakovitch, in press).

There is considerable evidence suggesting that the six-month-old infant who is beginning to touch and look concurrently at objects is also beginning to integrate visual and tactile information cross-modally (Bryant, Jones, Claxton, & Perkins, 1972; Gottfried, Rose, & Bridger, 1977; Rose, Gottfried, & Bridger, 1981a; 1981b; 1983; Ruff, 1984b; Ruff & Kochler, 1978). For the first time infants begin to show evidence of visually recognizing objects that have previously been presented tactually. In order to do this the infant must store some image of the object based on tactile experience and later match this memory with some aspect of the visual experience. It is believed that focused examination which involves simultaneous visual and tactile inspection of objects facilitates the development of this type of cross-modal integration.

Major changes are also occurring in the infant's other manipulatory skills through the emergence of the primitive pincer grasp and the development of voluntary release skills. Previously, when the infant wanted to release an object he or she did so with a total arm movement that often resulted in the toy being flung away. Infants now have enough control over fine motor movements that they can purposefully release objects without flinging, and can squeeze soft, pliable rubber toys. As a result of these developments, the infant's repertoire of behaviors, previously composed of only mouthing, grasping, looking, and banging, now expands to include a variety of manipulations such as striking, dropping, squeezing, stretching, etc. (Uzgiris, 1983).

The infant's repertoire of manipulative behaviors at first simply expands. Soon these behaviors come to be applied more discriminately according to the object's diverse characteristics (Piaget, 1952; Uzgiris, 1983). The infant on encountering an object for the first time is now concerned primarily with discovering the novel features of the object rather than just using it for exercising a schema. In other words the behavior is subordinated to the exploration (Piaget, 1952). Infants now spend considerable amounts of time looking at and exploring the objects making up their world--touching, mouthing, poking, turning, squeezing, etc.--discovering their unique characteristics and properties.

At this age infants focus on objects with all their senses, turning them over and over again while looking at them intently and listening to their sounds. A wide variety of complex and interesting "means" actions are repeated endlessly in order to find out how objects work and what they can do. From this point on, the infant continues to rapidly acquire new ways and methods for interacting with objects. These actions are distinguishable from the infant's past actions in that they are differentiated according to the object with which the infant is interacting.

They represent an adaption of the infant's actions to the particular characteristics of objects.

Infants now begin to persist in their actions toward a deliberate end, even if some barrier or frustration intervenes. Their actions become intentional and they become deliberate problem solvers, varying means to produce a desired end. The cognitive reorganization necessary for this intentional goal-directed behavior is believed to be strongly linked to earlier object manipulation and examination (Uzgiris, 1983).

Environmental Influences

While the infant's perceptual-cognitive skills emerge out of the newborn's abilities, these skills are also amenable to early environmental interventions. At early ages, attentional and exploratory behaviors are significantly and positively related to measures of the child's home environment, such as a responsive caregiver and an adequent provision of play material (Yarrow, Rubenstein & Pederson, 1975; Riksen-Walraven, 1979). These remain important determinants of exploratory behavior, even at older ages when the freedom to explore the environment visually and physically become additional determinents of developmental progress (Wachs, 1976).

Several studies have examined the relationship between exploratory behaviors and the young infant's experience with animate and inanimate objects. An early study by Rubenstein (1967) found that mothers who were highly attentive to their child tended to have children who engaged in more visual attention and more tactile manipulation than did mothers who were less attentive. A subsequent, more extensive, investigation revealed that it was specifically the caregiver's level, variety and responsiveness of behavior that was related to the infant's more advanced cognitive functioning (Yarrow, Rubenstein, Pederson & Jankowski, 1972; Yarrow et al, 1975). These studies found that level, variety and responsiveness of social stimulation were all significantly and positively correlated with the child's mental development, goal directed behavior (e.g., repetition of interesting results, skill in transactions with objects, and persistent attempts to obtain an object out of reach), and skill in object permanence. Subsequent studies have found that high maternal responsivity is associated with increased infant mastery (Yarrow, MacQuiston, McTurk, McCarthy, Klein & Vietze, 1983) and more rapid habituation of visual attention (Bornstein & Tamis, 1986).

This significant positive correlation between maternal responsivity and children's more advanced cognitive functioning has subsequently been reported by a number of different investigators (Barnard, Bee & Hammond, 1984; Beckwith & Cohen, 1984; Clarke-Stewart, 1973; Coates & Lewis, 1984). In addition, training caregivers to be more responsive to child behavior has been found to result in a corresponding increase in infant exploratory behavior (Riksen-Walraven, 1979). It has been hypothesized that the reason maternal responsivity is so important to child development is due to the contingency experience it provides for the child. A responsive caregiver allows the child to learn that he or she is effective in influencing the environment, and it is this expectancy that then enhances exploration and facilitates infant development (Ainsworth and Bell, 1973; Lewis & Goldberg, 1969; Gottfried, 1984).

Responsivity is also an important characteristic of the infant's inanimate environment. Toy responsivity and total toy variety are both positively correlated with numerous measures of infant functioning including mental development, motor development and attention to novel objects (Bradley & Caldwell, 1984; Gottfried & Gottfried, 1984; Siegel, 1984), as well as with fine motor skill in transactions with objects, repetition of interesting results, and persistent and purposeful attempts to secure out-of-reach objects (Yarrow, Rubenstein & Pederson, 1975; Yarrow, Rubenstein, Pedersen, & Jankowski, 1972). Toy variety is also positively correlated with problem-solving skills, object permanence, and manipulation of novel and familar objects (Yarrow et al, 1972).

A study by McCall (1974) extended these early findings by distinguishing between two types of toy responsivity, toys that provide primarily sensorimotor feedback (e.g., objects to bang) and toys that provide feedback matched to the child's cognitive abilities and interests (e.g., modelling clay). While manipulatory exploration was an increasing function of the variety of responsive toys to which the child had access, after six months of age the normally developing child was increasingly attracted to complex toys permitting appropriate and responsive interactions, not simply sensorimotor feedback.

Wachs (1976) undertook an extensive three year study relating the specific experiences encountered by infants to their concurrent cognitive-intellectual development. After following 39 children through the first two years of life he proposed three components necessary for an adequately stimulating home environment. First, every child requires adequate visual stimulation early in infancy and adequate tactile-visual stimulation later in infancy. Second, every child requires variety and change in stimulation. At younger ages this variety is provided for the child by the caregiver, while at older ages it is encouraged by a lack of visual and physical restraints on the child's exploration. Third and most important, every child requires a number of toys producing audio-visual feedback when activated. Wachs found that toy responsivity was the one home measure that was most consistently and significantly related to all aspects of cognitive development throughout the first year of life. These results were collaborated and extended by later researchers (Wachs, 1979; 1984; Wachs & Gruen, 1982). Gottfried & Gottfried (1984) found that the above measures were also related to infant recognition memory as indexed by familiarity and novelty preferences. Thus, early opportunities to explore a variety of animate and inanimate objects, especially those that are responsive to infant actions, are related both to the speed at which visual attention becomes habituated and to the amount of environmental exploration in which the child engages. Children experiencing more responsive home environments tend to engage in more manipulatory exploration and are more advanced in cognitive functioning. It is likely that such an environment provides the child with increasingly more complex and more stimulating environments to explore.

Summary

Within the first 12 months of life the normally developing infant changes from an immature organism unable to coordinate the movement of his/her limbs into a toddler who can purposefully reach for, grasp, and engage in refined exploration of objects. The child changes from a newborn infant totally dependent on his/her auditory and visual sensory systems to bring in information about the world, into an individual capable of controlling the amounts and kinds of environmental information to which he/she is exposed. While the newborn infant is dependent on inborn propensities to direct attention to relevant aspects of the environment, the toddler is able to use previously acquired information to guide present and future attention and exploration. The infant's ability to engage in tactile and visual inspection of objects and in refined exploration of their characteristic properties is critical in allowing him/her to learn about and attain mastery over the environment. Such skills are fundamental to all theories of cognitive development (Bruner, 1973; Piaget, 1952; White, 1959). While these skills are initiated by inborn propensities and newborn abilities that guide behavior in certain predetermined directions, they are amenable to environmental influence and are easily refined and elaborated by these early experiences.

Modifications in Development: Down syndrome

In contrast with the prolific research investigating sensory and perceptual skills in normal infants, research on the infant with Down syndrome is limited. Earlier researchers suggested that the Down syndrome infant had less than perfect visual acuity, reduced auditory discrimination, a diminished sense of smell, poor tactile ability and reduced heat-cold discrimination (Benda, 1969; Clausen, 1968; Gordon, 1944). However, these sensory abilities were typically measured by observing the infant's motor responses after stimulus presentation, and it has generally been acknowledged that motor responses are diminished in the Down syndrome newborn (Gibson, 1978). In fact, even reflexive responses are delayed or reduced in intensity. The immaturity of the Down syndrome infant's central nervous system may mean that more intense stimulation is required before a motor response will be produced (Benda, 1969). In any case most researchers agree that it is unlikely that purely sensory deficiences could underlie the perceptual-cognitive problems of the Down syndrome child, particularly since there is little correlation between the performance of Down syndrome children on sensory tasks and subsequent developmental progress (Gordon, 1944).

In general, developmental progress in the Down syndrome child is not linear as in normally developing children but shows deceleration over time so that with increasing age the Down syndrome child falls further and further behind in development (Carr, 1970; Dicks-Mireaux, 1972). This developmental decline is readily apparent by two years of age and has typically been attributed to impaired language and reasoning skills. However, more recent investigations have suggested that the developmental decline actually begins much earlier than two years (Dicks-Mireaux, 1972). There appears to be a steep decline in the Down syndrome child's developmental quotient (as measured by the Gesell scales) between the ages of four and ten months and then a more gradual deceleration to two years (Carr, 1970). Beginning at around eight months the Down syndrome child's development moves away from the normal linear age trend and starts to show a curvilinear relationship with increasing age (Dicks-Mireaux, 1972). While the basis of this developmental decline is yet unknown, it is clear that there are major deficits occuring much earlier than had previously been suspected which are not entirely due to sensory deficiencies or impaired language skills.

Kopp and Parmelee (1984) believe that this early developmental regression of Down syndrome children is the result of impaired information-processing skills. In the following review it will be shown that there is good reason to believe that the Down syndrome child has great difficulty processing information and that this difficulty extends across several modalities. Part of the reason for the decline in development in the Down syndrome child may be the increasingly large amounts of environmental information that these children are not accessing, information that is available to the normally developing child.

Reliance on Visual Information

Several investigations into visually mediated perception, attention, and memory (Cohen, 1981; Fantz, Fagan & Miranda, 1975; Miranda & Fantz, 1973; 1974; Miranda, 1976) have provided support for the belief that there is an information intake deficiency in the Down syndrome child. Using the visual preference and visual recognition paradigms these researchers have demonstrated that Down syndrome infants can discriminate among stimuli varying in a number of dimensions, and can store and retrieve such information early in the first year of life. However, there are some important delays and differences in the Down syndrome child's attainment of these skills when compared to the normally developing child.

An initial study (Miranda & Fantz, 1973) involving eight-month-old normal and Down syndrome infants found that while the Down syndrome infants looked longer at visual stimuli, they did not show any differential preference for nine pairs of patterns differing in depth, element arrangement and form contour. While normally developing children at eight months of age were showing a strong preference for circular over linear configurations, for three dimensional objects over two dimensional photos, and for schematic face-like configurations over abstract patterns, the Down syndrome infants showed no such preference.

A longitudinal study of Down syndrome and normal infants from 5 to 33 weeks of age was conducted to investigate these results more fully (Fantz, Fagan, & Miranda, 1975). Interestingly, few differences were found between the visual preferences of Down syndrome infants and normally developing infants at the earliest ages. Six pairs of stimuli varying in form or element arrangement that had not elicited a differential response in the eight month old Down syndrome infants were included in the study and each one elicited a reliable preference in the Down syndrome infants by two or three months. The younger Down syndrome infants showed a strong preference for curved over striped patterns, for checked over lattice configurations, for irregular over regular arrangements, and for schematic face patterns over scrambled versions. Furthermore, this preference was surprisingly strong between three and six months, equal to and in some cases exceeding that of the normal infant, particularily for the schematic face pattern. It is obvious from these results that the lack of differentiating response among the Down syndrome infants at eight months was not due to an inability to discriminate and select between patterns.

Beginning at six months the Down syndrome infants' preferences gradually dropped to chance levels resulting in the same type of group differences shown in the eight month study (Miranda & Fantz, 1973). The only differential responses that the Down syndrome children continued to show at eight months involved a preference for schematic faces over photos and for high contrast stimuli over those of lower contrast. These types of preferences drop out for the normal infant at four or five months, to be replaced by a preference for stimuli with more and subtler details and for stimuli with increased complexity. The authors suggest that for Down syndrome infants there is a prolongation of responses based on a more primitive stage of functioning and a concomitant delay in the development of more advanced perceptual skills. The failure of these infants to continue to discriminate and pay attention to such pattern variations as contour, form, and element arrangement may play an important role in their retarded cognitive development.

Fantz (1970) and Miranda (1976) believed that changes in visual preferences were a dual consequence of the child's stage of perceptual development and the impact of environmental experience and growth; furthermore, these changes in themselves became an important influence on subsequent development. While at birth visual attention is attracted to and held by patterns with certain contours and element arrangements, within three to four months many additional stimulus variables such as solidity, depth, subtlety of detail, variety of form and color become important. This change occurs as a direct result of the child's early and intense visual examination. Both Fantz & Miranda believed that this shift must occur before the child can progress toward more refined performance requiring attention to highly select parts of the environment and to the subtler features of that environment. They suggested that although both normally developing and Down syndrome infants come with the same wired-in propensities, the infants having Down syndrome were less able to use these propensities to acquire, store or retrieve environmental information necessary for perceptual learning.

Turning to memory capability, two studies by Miranda compared recognition memory in Down syndrome and normal infants using the habituation-dishabituation paradigm. In the first study Miranda (1970) reported that immediate recognition memory for easily discriminable abstract black and white patterns was present for both normal and Down syndrome infants at eight months of age. Although the Down syndrome infants looked longer at both stimuli, both groups showed a reliable novelty preference. However, Miranda felt that the study might not have adequately measured memory ability since the stimuli differences were numerous and apparent.

A follow-up study (Miranda & Fantz, 1974) increased the difficulty of the memory task and tested infants at three ages (13, 24 and 36 weeks). Three problems were used: a multidimensional pattern and variation presented in two different colors; photographs of an adult and an infant face; and patterns of squares differing in their arrangement. Each infant was tested for novelty preference after either 30 or 60 seconds of familiarization time, and either immediately after familiarization or after a one- or two-minute delay. In all cases Down syndrome infants looked longer but showed fewer preferences. The normal infants began to show novelty preferences for the simplest stimuli at 9 weeks, and by 24 weeks showed novelty preferences with all the stimulus problems. In contrast, the Down syndrome infants did not begin to show a novelty preference until 24 weeks, and even at 40 weeks did not show a reliable novelty preference for the square arrangements or color patterned stimuli. Varying the length of the familiarization or recall time had no effect on performance of either group. The Down syndrome infant's lack of preference was not the result of a failure to discriminate the patterns since the same subjects had showed discrimination between the patterns as early as five weeks; rather, these infants lacked the ability to remember the patterns to which they had previously been exposed. This provides support for the conclusion of a perceptual learning deficit in these children.

Cohen (1981) found simialr results in a study comparing Down syndrome and normal infants at 19, 23, and 28 weeks. Again the Down syndrome infants fixated the stimuli longer, but did not show the same preference for novelty until much later. The preferences shown by normal 19-week-old infants only became apparent in the Down syndrome infants at 28 weeks. One interesting observation made by Cohen concerned the extremely long visual fixations of the Down syndrome infant. A pattern of decreasing fixation to visual stimuli is shown by normally developing infants between 8 and 18 weeks. This failure of Down syndrome infants to exhibit a linear decrease in visual fixation over repeated habituation trials was also reported by Lewis & Brooks-Gunn (1984). Cohen believes that the longer fixation time of the Down syndrome infant is indicative of an information processing problem and that these infants require more time to process stimuli. Given that longer familiarization times did not substantially improve the Down syndrome child's performance (Miranda & Fantz, 1974), it may be that the problems these children have in information processing goes beyond a simple time requirement.

Another study addressing more directly the issue of prolonged visual fixation in children with Down syndrome but with no visual impairments was conducted by Berger and Cunningham (1981). They recorded eye contact between mothers and their normal or Down syndrome infants over the first six months of life during a naturalistic interaction condition and a second condition where caregivers were instructed to remain silent and immobile. The Down syndrome infant's development of eye contact was characterized not only by chronological delays in onset but also by qualitative differences in developmental pattern. Eye contact began in normal infants at around 4 weeks of age, increasing over age to show two pronounced peaks. The first at 7 weeks was characterized by eye contacts of prolonged durations, while the second at 14 weeks was characterized by shorter gaze durations with frequent shifts of attention from the mother's eyes to other parts of her body, the surrounding room, or the infant's own hands. At this same time a more discriminate use of eye contact was observable, with significantly more eye contact in the naturalistic condition and less in the silent condition.

This double peak pattern was not observed for any of the Down syndrome infants. For these infants eye contact appeared at 7 weeks and continued to increase over the course of the study. There was no shift from longer to shorter gaze durations and no differentiation of behavior between the mobile and immobile conditions. The authors believe that the high level and prolonged duration of eye contact in the Down syndrome infants indicates some impairment of the information processing system and the learning process. The failure to obtain an age related increase in preference for the mobile face may represent an impairment or delay in the discriminatory and intentional use of eye contact.

The Down syndrome infant's different pattern of eye contact has also been commented on in studies of slightly older infants (Anwar, 1983a; 1983b; Jones, 1977; 1980; Krakow & Kopp 1983; Loveland, 1987). Both Jones (1977; 1978) and Krakow & Kopp (1983) found that whereas normal infants frequently look away from their mother to some aspect of their environment, Down syndrome infants spend a substantial amount of time fixated on the mother's face. These children have a particular difficulty with referential eye contact, a complex skill where the child must pause, direct eye contact to the mother in a primitive inquiry, and upon receiving a maternal response redirect attention back to the task with which they had been engaged. In general, these children have problems with directing attention. Whereas the normal child fully scans a visual stimulus, children with Down syndrome tend to fixate their attention on a single aspect of an image (Anwar, 1983a; 1983b; House & Zeaman, 1960) and become confused when a task demands attention to more than one stimulus dimension (Stratford, 1980). Loveland (1987) found that Down syndrome infants have great difficulty shifting attention between stimulus pairs, especially when this is required for exploratory or comparison purposes (for example when comparing a person or object with their mirror image). Loveland felt that it was the attentional and task-related demands of these types of strategies that posed the greatest difficulty for these children.

In summary, these studies show that Down syndrome infants have the ability to acquire, store and retrieve information at an early age. However in comparison to normally developing children, the Down syndrome child shows a delay in the onset of information processing skills and an impairment in the ability to take in and learn from an information-rich environment. While these infants come equipped with the same basic propensities that guide early visual preferences in the normally developing child, there appears to be a difference in the quality of early visual skills and in the timing of skill emergence. The Down syndrome child appears to have great difficulty using inborn propensities and early visual skills for the acquisition, storage, and retrieval of environmental information. When inborn propensities begin to decline in the second half of the first year and attention comes to be guided by the infant's current knowledge of the world, there appears to be little stored information to guide the Down syndrome child's attention. This could, in part, explain some of the early developmental declines characteristic of these children.

Focused Attention and Manipulation

In the first six months of life the infant is dependent on the distal sensory systems, particularily on vision, to bring in information about the world and its objects. In the second six months, learning is dominated by the infant's store of knowledge about the world. Attention comes to be increasingly directed towards objects that can be both looked at and manipulated. The normally developing infant begins to depend more and more on the proximal senses and his or her newly emerging motor skills to initiate and coordinate environmental exploration, selectively reaching for, grasping, and manipulating objects in the environment.

In order for young infants to interact effectively with the environment they must be able to establish and maintain their body in position against the force of gravity, they must perfect the fine motor skills necessary for reaching, grasping, manipulating and releasing objects, and they must acquire the basic locomotor skills that will allow them control of environmental exploration. From its beginning, the motor development of the Down syndrome child is characterized by an abnormal timetable for the emergence and dissolution of reflexes and by muscular hypotonia (Henderson, 1985). Both of these interfere with normal motor development necessary for sitting without support and for manipulating small objects, thus making it more difficult for these children to make contact with and explore objects in their environment.

The effects of hypotonia and reflexive abnormalities on the child's gross motor development have been well documented (Cowie, 1970). It is very difficult for the Down syndrome child to develop the extension and stability in head, upper trunk, and shoulders necessary for the normal prone progression. These infants often have insufficient trunk extension to sit alone, and when placed in a sitting position will fall forward with head and chest between the legs. When the child does learn to sit unsupported, it is usually in an exaggerated trunk flexed position with the legs widely abducted and outwardly rotated, and the arms pulled back for balance. The child then becomes locked into this one position and finds it extremely difficult to move back and forth from this position to a recumbent one (Henderson, 1985).

Since these early motor skills form a hierarchical system with later postures growing out of and dependent upon the development of earlier ones, failure to calibrate earlier positions makes the acquisition of later ones more difficult (Butterworth & Hicks, 1977; Butterworth & Cicchetti, 1978). Thus, the Down syndrome child's motor development begins to fall further and further behind that of the normally developing child and takes on an increasingly abnormal appearance. For example, moving from a recumbent to a sitting position is accomplished by abducting the legs widely while lying prone, then arching the back and pushing up with the arms (Henderson, 1985).

Inadequate calibration of these early postures also impedes the development of fine motor skills. The development of reaching, grasping and manipulatory behaviors requires the child's trunk as a stable frame of reference. By impeding the Down syndrome child's acquisition of this stable frame of reference, muscular hypotonia and reflexive abnormalities indirectly make it more difficult for these children to engage in early environmental exploration and manipulation.

There is a dearth of studies dealing directly with development of manipulation skills in the Down syndrome infant, despite the importance of such skills for environmental exploration. Pueschel (1984) found that reaching for objects begins early in the Down syndrome child, sometime before six months of age. In fact by six months many of the children in her study had already progressed beyond a primitive grasp and were well on their way to using a more mature pincer grasp to pick up small objects. By 12 months of age more than 50% of the children were using a pincer grasp and 80% of the children were able to transfer objects from hand to hand. While it is apparent that the Down syndrome child has the fine motor skills necessary for making contact with objects in the environment from an early age, few studies have investigated their use of these skills in exploring and interacting with objects in their environment.

It is generally agreed upon that 6 - 12 month old infants having Down syndrome spend a greater proportion of time than normally developing children of this age in visually attending to objects without manipulating them (Krawkow & Kopp, 1983; McTurk, Vietze, McCarthy, McQuiston, & Yarrow, 1985; McTurk & Yarrow, 1985). While Down syndrome infants of all ages spend more time looking at novel toys and less time in mastery behaviors, this looking behavior does show some decrease between six and twelve months. At this same time these children's exploratory behaviors (the total of touching, mouthing, holding, examining, banging, shaking, hitting, dropping, rejecting and offering) begin to increase. Vietze, McCarthy, McQuiston, McTurk and Yarrow (1983) found that by 12 months of age Down syndrome infants were spending the same amount of time in exploratory behavior as were normally developing six month old infants.

Bradley-Johnson, Friedrich & Wyrembelski (1981) found no differences between 10- to 14-month old Down syndrome and normally developing children in their visual attention to or manipulation and mouthing of familar objects, although there were differences in their manipulation and mouthing of novel objects. They suggested that the Down syndrome child's over-reliance on visual information and under-utilization of manual exploratory skills may occur primarily with novel objects. These children spent significantly less time mouthing and manipulating novel objects than did the normally developing children. Differences were also found in the Down syndrome child's behaviour toward novel objects over the course of the experimental trial. There was a consistent response decrement in the manipulation of novel stimuli across trial blocks for the Down syndrome children but not for the normally developing children. The Down syndrome infants manipulated the novel object less and less as they were presented repeatedly, while normal infants retained their responsiveness over many trials. The authors concluded that while novel stimuli typically tend to have an arousing effect on sustained attention in the normally developing child, this is not the case with the Down syndrome child. These infants tend to retreat from novel stimuli, continuing to observe but not manipulate them. The authors suggested that the differences in the learning rates for these two groups of children may be primarily the result of the greater amount of information that the normal infant receives through its mouthing and manipulating of novel objects.

Another study (Loveland, 1987) found no significant differences in the exploratory behaviors of older 18 - 32 month old Down syndrome infants and their mental age match controls. However, the range of strategies utilized by the Down syndrome children in their exploration was much broader and less focused than that of normally developing children. Loveland felt that this failure to become more selective, more systematic, and better adapted to the specific situation may make for less effective perceptual learning in these children.

In the normally developing child it is focused examination, which involves both sustained visual inspection and simultaneous object manipulation, that forges the link between visual and tactile information systems. No study has directly investigated focused examination in children with Down syndrome. Dunst (in press), in a study using the Uzgiris-Hunt Scales of Infant Development to study sensorimotor development in Down syndrome children, found more deviations in the attainment of specific sensorimotor skills in these children than in normally developing children. In particular, he found that visual inspection of objects in an exploratory manner (focused examination) is an unusually late developing skill in the Down syndrome child. In fact, he found that these children demonstrate complex actions with objects before they engage in simultaneous visual and manual examination. This reversal in the Uzgiris-Hunt scale has never been reported in normally developing children.

There are several studies suggesting that Down syndrome children may have a basic difficulty in integrating tactile and visual information. Lewis and Bryant (1982) found differences between Down syndrome and normal infants in tactile and visual discriminatory skills and they attribute this difference to special problems these children have in integrating visual and tactile information. Two groups of Down syndrome and normal infants matched on mental age (12 and 17 months) were required to visually recognize two objects that had been previously presented either tactually or visually. Although even the youngest group of normal infants were able to discriminate both shapes in either condition, the Down syndrome infants had difficulty with all discriminations. The only stimulus discriminated by the Down syndrome child was a visually presented ellipsoid shape, and this discrimination was made by only the oldest group.

A second experiment allowed the infants to touch some of the visually presented stimuli. Normal infants spent more time than did Down syndrome infants looking at and simultaneously looking at and touching the stimuli. The Down syndrome infants looked less at the touchable objects, discriminated the objects less well, and touched the objects less frequently. Lewis and Bryant (1982) concluded that there is both a visual and a tactile deficit, as well as an inability to integrate these two modalities, that is present early in life, lasts through adulthood, and may lead to a serious gap in the Down syndrome child's perceptual experience.

The problems these children have in acquiring, storing and retrieving visual information have been discussed in previous sections. That these children have great difficulty with tactile information has also been frequently commented on in the literature (Gordon, 1944; Lewis & Bryant, 1982; O'Connor & Hermelin, 1961). In studies requiring children to recognize objects previously explored either haptically or visually, it is typical for Down syndrome children to recognize only the visually presented objects even though normal infants recognize objects presented in either manner (O'Connor & Hermelin, 1961; Komiya, 1981; 1982). However, since the recognition phase of these research studies have included only visual stimuli, it is difficult to determine whether the results are due to a tactile deficit or a visual-tactile integration deficit.

Few of these recognition studies have investigated the manner in which the child manually explores the object to be recognized, even though this should greatly affect accuracy. Davidson, Pine, Wilksesketten-Mann, and Appelle (1980) noted informally that Down syndrome individuals seem to adopt a different type of tactile exploration than do normal individuals. Anwar (1983b) found that when she imposed order on the extraction of tactile information by the Down syndrome children they were much better at reproducing the haptically presented shape. Physically guiding the Down syndrome child's finger around the shape exploring its distinctive contours resulted in much better discrimination under tactile presention. Under these conditions, the Down syndrome child's recognition of tactually presented objects was better than their recognition of visually presented objects.

Thus, it appears that part of the Down syndrome child's difficulty with tactile information may be the result of a difficulty in attending to the relevant dimensions and in extracting good quality distinctive information that allows for the object's later identification. These children may not spontaneously engage in the same types of refined tactile exploration as normally developing children, even though they may be capable of extracting, storing and retrieving such information when their attention is physically guided during the initial exploration. This refined tactile exploration may be the critical component in later object recognition.

Down syndrome children also perform better on cognitive tasks when their attention is externally guided. Moress (1984) found that Down syndrome infants were much more successful at sensorimotor tasks when the problem was presented in a manner that encouraged the infant's attention to the sequence of steps. When the Down syndrome child failed a task, breaking down the task and focusing the child's attention on the individual steps in the sequence frequently resulted in task success. This procedure was not very effective with a control group of normal infants. For normally developing children restructuring the task presentation did not improve performance, presumably because their failure was not the result of attentional deficits. Moress concluded that the normal approach to cognitive development involves the infant imposing more and more order on his or her environment. The Down syndrome child may be much less well equipped to structure the environment and can benefit from the deliberate structuring done by a parent or educator.

In summary, the hypotonia and reflexive abnormalities associated with Down syndrome make it more difficult for these children to maintain their body in position against the force of gravity. This impedes the acquisition of skills necessary for examination and exploration. As in visual learning, these differences and delays in early skill attainments make it more difficult for the child to acquire information through tactile exploration and examination. As a result, environmental exploration begins in the Down syndrome child with a heavy reliance on visual attention, with manual exploration only beginning to appear at around 12 months of age. This shift from visual to manual exploration occurs in the normal infant at around six months of age. The overreliance of Downs children on visual information may be, in part, the result of a difficulty in dealing with tactile information or in integrating visual and tactile information. Focused examination which requires the child to visually observe the effects of his or her tactile manipulations on the object, integrating visual with tactile information, appears to develop particularly late in these children. Deficiencies in focused examination and in tactile exploration can have important ramifications for the child's acquisition of new information from the environment since focused examination and tactile exploration provide specific information about the distinctive characteristics of objects. The improvements in performance that have been possible when the child's attention is specifically directed to the relevant aspects of the stimulus presentation implies that attention focusing may be important in the development of these skills in the Down syndrome child.

Home Environment

There have been few studies investigating the home environment of Down syndrome infants and how it may affect their perceptual-cognitive development. Piper and Ramsey (1980) found that measures of the Down syndrome child's home environment, such as poor organization of physical and temporal environment, fewer provisions of appropriate play materials, and less maternal involvement, were all associated with slower developmental progress by the child. These findings are similar to those reported for normally developing children (e.g., Wachs 1976).

Smith and Hagan (1984) found that caregivers of infants having Down syndrome provided household/caretaking objects for their child's play less frequently than did caregivers of normally developing children, even though this measure was highly positively correlated with the child's concurrent and subsequent development. They also found that caregivers of normally developing children talked more frequently to their child with reference to the environment, giving more definite directions and providing more specific references, while caregivers of Down syndrome children tended to smile more and engage in more deliberate active physical stimulation. The amount of physical stimulation from the caregiver was negatively correlated with the amount of focused examination engaged in by the child. The amount of focused examination shown by the child and the caregiver's verbal mediation were both positively correlated with subsequent infant performance at 24 months. The authors concluded that the early home environment was very important for the developmental progress of the Down syndrome child, with the provision of objects for play and opportunities for focused examination being of particular importance for these children.

Several studies have found that caregivers of Down syndrome infants are less responsive than are caregivers of normally developing infants (Berger & Cunningham, 1981; Jones, 1977; 1980). They tend to overstimulate their child verbally, talking too much to the Down syndrome child and not allowing the child sufficient time in which to respond. However, other research has found that maternal responsivity is not highly correlated with developmental progress in Down syndrome children in early intervention programmes (Cunningham and Crawley, 1983). In the latter study, an optimal combination of sensitivity, elaborativeness, and directiveness provided an environment most conducive to the Down syndrome child's developmental progress.

Summary and Conclusions

Theoretical and empirical work has focused on the importance of attentional and explorational skill for the child's perceptual-cognitive development. These behaviors are seen as reflecting current cognitive functioning, while at the same time providing the infant with the means for procuring additional knowledge about the world. In their role as learning tools, these abilities directly influence both the quantity and quality of information that the child receives from the environment. As such they directly influence the course of the child's future cognitive development.

There is an intrinsic motivation in the normally developing child to attend to, manipulate, learn about, and master the environment. This motivation can be seen in behaviors such as the child's selective interest in and preferential attention to novel objects, the child's persistent attempts to grasp and manipulate contacted objects, the child's determined efforts to elicit responses from objects, and the child's persistence in task mastery. There is good reason to believe that the Down syndrome child may not be as efficient as is the normally developing child in these areas. This can have important ramifications for the Down syndrome child's ability to acquire information from the environment and for the child's development.

From birth, the normally developing child not only selectively fixates the visual world, preferring to look at certain patterns over others, but also shows evidence of taking in such information, processing it and remembering it. Newborn preferences are the result of wired-in propensities that guide the infant's learning experiences in specific predetermined directions; however, the information the infant is acquiring through this visual examination quickly comes to control his or her attention, serving as a guide for subsequent visual exploration. This control is observable in the regular shifts in visual preferences occurring at varying intervals in the child's developmental progress (e.g., the shift in visual interest toward stimuli that are more complex and have subtler detail).

One very important developmental shift in attention occurs in the latter half of the first year, occurring concurrently with improvements in the infant's motor abilities. At this time infant attention is no longer held by solely visual stimuli; objects that can be both looked at and manipulated hold a much greater attentional value. At first the infant is concerned primarily with what manipulations he or she can engage in to gain immediate contingent feedback from the object, with the focus being entirely on the infant's actions and not on the object. However, this focus soon shifts from the action to the object. The infant's interest in novel objects now takes the form of an intense visual and manipulatory examination (focused examination), combined with a more complex investigation of the subtler details of the object's functioning (complex exploration). During this examination and exploration the child is learning a great deal about the object and its distinctive characteristics, as well as learning a sense of competence and mastery over the environment; skills that are fundamental to all theories of cognitive development.

A review of the literature on infants having Down syndrome reveals important differences in the range and emergence of early attentional and explorational skills. The same wired in propensities that guide perceptual development in the normally developing child are apparent in the behavior of the Down syndrome infant; however, there are differences in the emergence and development of early visual and manipulatory skills. Consequently, these children are less able to use these propensities to acquire, store and retrieve the environmental information necessary for perceptual-cognitive growth. The Down syndrome infant's visual behavior is characterized by prolonged periods of visual fixation and a corresponding inability to shift attention between stimuli or among different aspects of the same stimulus. Despite this intense visual regard, the Down syndrome child demonstrates fewer differential preferences and less recognition of previously presented stimuli than does the normally developing child. There appears to be a delay in the development of more advanced perceptual skills in the Down syndrome child. This delay becomes increasingly apparent toward the latter half of the first year at the time when acquired information typically begins to guide visual attention and exploration.

The Down syndrome infant's motor behavior appears equally deviant. The abnormal reflexive behavior and hypotonia characteristic of Down syndrome makes more difficult the attainment of gross motor skills such as sitting and walking. While the development of fine motor skills appear to be less affected than are gross motor skills, the Down syndrome child is less capable of using these skills for object examination and exploration. These children spend very little time manipulating novel objects and a great deal more time merely looking at them. They appear to have a special difficulty with tactile information or perhaps in integrating tactile with visual information. As a result, developmental skills leading to focused examination and to more complex object exploration may be particularily deviant. These skills are particularly important for obtaining information about the environment and about objects in that environment.

Present Study

The present study investigated the 11- to 15-month-old Down syndrome child's ability to take in environmental information through visual attention and tactile exploration by comparing the Down syndrome child's skills in these areas with those of normally developing children. It was expected that attention and exploratory abilities would be related to the length of the child's experience with the environment, the child's current cognitive functioning, and the child's skill in fine motor manipulation. Advances in all three of these areas typically occur simultaneously in the normally developing child, but development need not necessarily progress at the same rate in each area for the child with Down syndrome. Consequently, the behaviors of the Down syndrome children were compared with those of three individually matched groups of normally developing children: a chronological-age-matched group, that presumably had similar exposure to objects and people in the environment; a mental-age-matched group that was at a similar stage in cognitive development; and a motor-age-matched group that had similar manipulatory skills available for interacting with the environment. Each normally developing child was also matched as closely as possible to the Down syndrome child on a number of background variables, including child sex, child ordinal position, maternal education, paternal education, and family socioeconomic status.

Videotaped records were made of each child during a 16 minute teaching/play episode. The stimuli consisted of a set of four novel, commercially-available toys producing a variety of audio-visual responses upon manipulation. Novel, commercially-available toys were selected because they represent a common but important opportunity for childhood learning. Toys were chosen that could be manipulated in a number of ways to produce a variey of responses since this type of toy is considered very attractive to children within this developmental age range, and because it allowed for the maximum amount of exploration and examination.

At the beginning of each play session the caregiver demonstrated each toy's responsive features to the child and directed the child's attention specifically to one easily reproduced response (the mastery task). Each videotape was subsequently scored for the child's attentional behaviors, the child's exploratory behaviors, and the caregiver's teaching style.

Two separate hypotheses were made about the Down syndrome infant's attentional behavior. It was hypothesized that the Down syndrome infant would spent a greater amount of time than would the normally developing child in vision alone, but a lesser amount of time in vision with manipulation. This hypothesis was based on previous research showing that 12 month old Down syndrome infants spend more time in visual regard and less time in manipulation of novel toys (Vietze et al, 1983) and that these children have particular difficulty in integrating visual with tactual information (Lewis & Bryant, 1982). It was also hypothesized that the Down syndrome children's attentional focus would remain firmly on the toys resulting in less offtask and less social interactive behavior in these children than in normally developing children. This hypothesis was based on the Down syndrome child's prolonged visual fixation times and apparent inability to shift attention between stimulus elements (Miranda & Fantz, 1974; Cohen, 1981; Berger & Cunningham, 1981).

Three distinct hypotheses were made about the child's manipulatory behavior. It was hypothesized that Down syndrome children would engage in more simple object exploration and less complex exploration. This hypothesis was based, in part, on past research showing that these children engage in less overall exploration than do normally developing children of the same age (Vietze et al, 1983). However, these researchers did not differentiate between the various types of object exploration, combining them into one overall score. Given the Down syndrome child's difficulty in attending to the subtler aspects of visual stimuli (Fantz, Fagan & Miranda, 1975), it seemed reasonable to hypothesize that these children would have greater difficulty with complex exploration than with simple exploration.

It was also hypothesized that Down syndrome children would not differ from the normally developing children on mastery of the caregiver teaching task. This hypothesis was made on the basis of research showing that Down syndrome children are more likely to show task success when their attention is specifically directed toward the relevant aspects of a stimulus display (Anwar, 1983a; 1983b; Moress, 1984).

In addition, it was hypothesized that the Down syndrome child would engage in much less focused examination than would the normally developing child. This hypothesis was made on the basis of research demonstrating the difficulty that these children have with tactile information and in integrating tactile information with visual information (Lewis & Bryant, 1982). It is interesting to note, however, that if the Down syndrome child actually required more time to process information as some early habituation studies have suggested (e.g., Cohen, 1981), then these children would have to engage in more and not less focused examination in order to gain the same amount of information received by the normally developing child.

Three hypotheses were made regarding the responsiveness of the Down syndrome child's home environment. It was hypothesized that Down syndrome children would have access to fewer responsive toys than would normally developing children. This hypothesis was made on the basis of research showing that these children have access to fewer household objects for play (Smith & Hagan, 1984) and caregiver reports that these children are not provided with such toys because of an apparent disinterest (Vietze et al, 1983).

It was also hypothesized that caregivers of Down syndrome children would be less responsive in their interactions with their child in the teaching/play session than would caregivers of normally developing children. This finding frequently has been documented in previous research on Down syndrome children and their caregivers. Caregivers of Down syndrome children tend to be less responsive to their child's behavior, overstimulating the child both verbally (Berger & Cunninghan, 1983; Jones, 1978; 1980) and physically (Smith & Hagan, 1984), without adequately mediating the child's interactions with his or her environment (Smith & Hagan, 1984).

In normal infant-caregiver interactions there is an appearance of synchrony and responsivity primarily because caregivers tend to perceive and respond to infant behavior as if it were intentional long before it truly is purposeful (Kaye, 1982; Maccoby & Martin, 1983). It may be that caregivers are less responsive to the Down syndrome child than to the normally developing child because they see the Down syndrome child's behavior as becoming intentional only at a later age. If behavior is not intentional, then there is less obligation for the caregiver to respond, elaborate or mediate with the child having an active role in the interaction (Skinner, 1985) and more of a tendency to provide for the child (e.g., stimulate). The final hypothesis explored the possibility that caregivers perceive the Down syndrome child's behavior as not being intentional at the same age as is that of the normally developing child.

In summary, eight specific hypotheses were investigated in this present study.

1. Infants with Down syndrome will engage in more vision alone and less vision with manipulation than will normally

developing infants.

2. Infants with Down syndrome will engage in less offtask and less social interactive behavior than will normally developing infants.

3. Infants with Down syndrome will engage in more simple exploration and less complex exploration than will normally developing infants.

4. Infants with Down syndrome will not differ from normally developing children on the duration of their mastery behavior.

5. Infants with Down syndrome will engage in less focused examination than will normally developing infants.

6. Infants with Down syndrome will have fewer responsive toys in their home than will normally developing infants.

7. Caregivers of infants with Down syndrome will be less responsive in their interactions with their child than will caregivers of normally developing infants.

8. Caregivers of infants with Down syndrome will perceive their child's behavior as less purposeful or less intentional than will caregivers of normally developing children.

CHAPTER II

METHOD

Subjects

Sixty infants between the ages of 6 and 15 months together with their caregivers participated in this study. Fifteen of the infants had Down syndrome, while the remaining 45 infants were normally developing children who served as mental-, motor-, or-chronological-aged-matched comparisons.

All Down syndrome child-caregiver pairs were participants in the British Columbia Infant Development Programme and were contacted through their programme worker. A total of 24 families were contacted. Of that total, three families refused to participate on emotional grounds and six families agreed to participate but were unable to do so. In each case the child died before reaching the appropriate age for the study. The majority of Down syndrome infants were diagnosed by cytogenetic analysis as possessing the trisomy 21 variant of Down syndrome.

The comparison families were drawn from a file of volunteers contacted at Greater Vancouver hospital maternity wards at the time of the child's birth. A total of 83 families with normally developing children were contacted and only two families refused to take part in the study. In both cases the families refused on the grounds that they no longer had time to participate in research. The forty-five comparison families were then chosen from this subpopulation on the basis of the best match to a Down syndrome child.

Matching was done on the basis of each child's score on the Bayley Scales of Infant Development (Bayley, 1969). This scale has the advantage of providing separate mental and motor developmental quotients and was used to ensure appropriate matches in each of these areas. Each Down syndrome child was paired with a normally developing child of similar mental age, with a child of similar motor age, and with a child of similar chronological age. This procedure resulted in the formation of three comparison groups each with 15 normally developing children: a mental-age-comparison group, a motor-age-comparison group, and a chronological-age-comparison group. The mean mental, motor and chronological ages for each of these three groups of children can be found in Table 1.

Each group of normally developing children was matched as closely as possible to the Down syndrome group on a number of demographic variables. One of these demographic variables was family socioeconomic status (SES), as determined by the parents' score on the Siegel Prestige Scale (1971, cited in Hauser & Featherman, 1971). In this scale, parents' responses to questions regarding their job title, their type of business, and whether or not their business is privately-owned, self-owned, or government-owned are used to determine their job classification code. This classification code is based on the 1970 detailed Industry and Occupation Codes, U.S. Bureau of the Census. Each

Table 1

Mean Age Scores in Months For Each Group

	Motor Age	Mental Age	Chronological Age
Down syndrome	8	10	13
Motor Matches	8	9	9
Mental Matches	10	10	10
Chronological Matches	11	13	13

Mean Scores and Standard Deviations

	Motor[1] Age		Mental[1] Age		Chronological Age	
	x̄	sd	x̄	sd	x̄	sd
Down syndrome	34.9	6.3	91.0	9.6	13	1.5
Motor Matches	37.0	6.4	83.5	8.9	9	2.1
Mental Matches	41.6	5.4	92.0	9.6	10	2.1
Chronological Matches	46.2	3.4	106.9	6.4	13	1.5

Note: 1. Means (x̄) and standard deviations (sd) for motor ages and mental ages are in Bayley Standard scores.
2. Means (x̄) and standard deviations (sd) for chronological ages are in months.

classification code has assiged to it a score on the Siegel Prestige Scale ranging from 0 - 100, with higher scores being assigned to those jobs rated as more socially prestigous (e.g., lawyer, doctor). Each group was also matched as closely as possible to the Down syndrome group on a number of other demographic variables such as parental education, sex, and ordinal position. There were no significant differences between the groups on any of these demographic variables. Mean scores for each group on continuous variables and the number of caregiver/children for each group within each category for categorical variables can be found in Table 2.

The majority of the children came from middle class backgrounds and all the children had two parents present in the home. For 58 of the children the principal caregiver was the mother; for two of the normally developing children the principal caregiver was father. For these latter two cases only, the child's father was interviewed and appeared in the videotape.

Table 2

Demographic Information For Each Group

	Down syndrome		Mental Age		Motor Age		Chrono-logical Age	
Mean and standard deviation on each continuous variable	M	sd	M	sd	M	sd	M	sd
*Maternal Education	13.7	2.5	13.2	1.6	13.9	2.3	13.9	2.3
*Paternal Education	13.3	3.1	13.7	3.7	13.5	2.3	13.8	2.6
**Maternal SES rating	40.8	11.4	40.3	11.4	44.6	11.9	44.8	8.4
**Paternal SES rating	44.9	14.3	39.8	13.7	42.2	12.9	46.6	16.3

Number of Caregivers/Children on each Categorical Variable	Down syndrome	Mental Age	Motor Age	Chrono-logical Age
Nonworking Mothers	5	9	4	5
Birth Order				
Firstborn	5	9	4	5
Laterborn	10	6	11	10
Sex				
Female	11	10	7	8
Male	4	5	8	7

* Education is in years.
** SES ratings derived from Siegal (1965 NORC Prestige Scale, as cited in Hauser and Featherman, 1977).

Materials

Bayley Scales of Infant Development

The Bayley Scales of Infant Development were designed to provide an adequate measurement of the developmental progress of infants between birth and thirty months. The Mental Scale is designed to assess sensory-perceptual abilities, problem-solving abilities, early verbal communications, and more abstract abilities involving generalization and classification. The Motor Scale is designed to measure the infant's body control, coordination of large muscles, and manipulations involving fine-motor skills (Bayley, 1969). Bayley's normative sample consisted of 1262 normal infants from the United States. Split-half reliablities for the Mental and Motor Scales average .86 (Yang & Bell, 1975). Psychometrically, the Bayley Scales are considered to be one of the most reliable and valid of the traditional infant assessment tests (Yang & Bell, 1975).

Questionnaires

Two questionnaires were developed by the researcher for use in this study. The Toy Scale, is an inventory of commercially-available toys responsive to infants' actions. Toys were identified as responsive if they contained features that produced auditory, visual or tactile feedback in response to child manipulation (e.g., chime balls, jolly jumpers, musical instruments, etc.). This definition of responsiveness is congruent with that of McCall (1974) and Yarrow et al. (1972).

This toy inventory provided a measure of the number of responsive objects available in the home for the child's play (see Appendix A).

The Infant Intentionality Questionnaire was designed by the researcher to assess the caregiver's feelings about his or her child's development of intentional behavior. Specific questions dealt with the caregiver's perceptions of intentionality behind such common infant behaviors as smiling or crying. In each case the caregiver was required to decide at what age (in months) they believed that the child first engaged in the behavior (e.g., smiling because he/she recognized you or becoming frustrated because a toy was out of reach). This questionnaire provided an indication of the caregivers' perceptions of their child's development of goal directed behavior and responsivity.

Both of these questionnaires were administered through a parental interview which took place on a home visit. Copies of both questionnaires are included in Appendix A.

Toys

The toys selected were designed for normal infants over 6 months of age and were similar to toys found interesting by 8- to 12-month-old Down syndrome infants in a study by Vietze et al (1983). Two were primarily effect-production toys having numerous moving parts providing auditory, visual or tactile feedback. Both of these were Duplo toys that could be taken apart and put back together again. The first was a rattle composed of a movable duck's head on top of a four-wheeled-spinning base. The second was a manipulable horse and rider on a base that could be either rocked or pulled. Both were brightly colored and had movable parts that produced different sounds when manipulated. The other two toys were primarily problem solving toys which required the child to make a specific response in order to obtain a toy that was out of reach. One toy was placed on a cloth so that the child had to pull the cloth to obtain the toy and the other was placed behind a transparent barrier that had to be circumvented to obtain the toy. Once obtained, these two toys were also responsive to infant manipulation. The first was a clear glass ball partially filled with water in which two brightly colored ducks floated. These ducks moved and produced noises when the ball was shaken or rolled. The second was a soft rubber turtle that produced noises when squeezed, and jumped when patted. All four toys were selected specifically for their responsiveness to minimal child manipulation, and for their unfamiliarity to the children. Each parent was questioned and each reported that their child had not had prior exposure to these toys.

Procedure

Each child and caregiver was first visited in their home. The Bayley Scales of Infant Development (Bayley, 1969) were administered to each child to measure the child's level of functioning in both mental and motor skills and to ensure that the appropriate matches were made. Immediately following this, the Toy Inventory and Child Intentionality Questionnaire were completed through an interview with the caregiver. An appointment was then arranged with the caregiver and child for the subsequent videotaped session on the university campus.

Each child-caregiver pair was videotaped at the university during a 16 minute teaching/play session. The videotaped sessions were conducted in a 3.1 meter by 4.6 meter carpeted playroom on the university campus. The playroom contained a chair, a highchair, and a coffee table containing the four toys arranged in the order of presentation. Two videocameras equipped with standard lenses were positioned in opposite corners of the room. One camera was focused on the caregiver's face, while the other camera recorded the infant's play behavior with the toys. The camera images were fed through a split-image generator that produced a videotape recording of each infant's actions, with the image of the caregiver's face positioned in the upper left-hand-corner of the tape. An Altec Lansing omnidirectional microphone (model # 5606) was suspended from the ceiling in the center of the room. The videorecorder was equipped with a RCA Date-Time Generator (Model # 1440A), which produced a time record on the videotape.

The session began with the experimenter discussing each of the four toys with the caregiver (children were present during this instruction period, but were occupied with other nonexperimental toys). Caregivers were informed that each toy could be played with in a number of different ways to produce responsive feedback and that there was a specific task designed for each toy. These responsive features and toy tasks were then demonstrated to the caregiver and they, in turn, were asked to demonstrate them to the child. Appendix B contains the complete toy instructions given to each caregiver. Caregivers were specifically instructed that there was no right or wrong way to play with the toys and that they could allow the child to play with the toy in whatever manner he or she chose. In addition, they were encouraged to interact naturally with the child during the videotaping (e.g., they could return a dropped toy or redemonstrate a toy if they felt it was necessary). The experimenter returned at the end of each four-minute period to hand the caregiver the next toy. After all four toys had been demonstrated and played with, caregivers were permitted to view the videotape and discuss the study with the experimenter.

Coding

The videotapes of the child and caregiver teaching/play episodes were coded continuously on an Apple IIe computer using the ABC (Apple Behavior Collection Program) data system developed by Howard Gabert, P. Eng., SFU Psychology Department. This system allows for the collection of data over specified time periods in a priority (higher behavioral codes take precedence over lower codes) manner. Coded data are stored on a floppy disk and can be reproduced directly or put into summary statistics of accumulated durations and frequencies for each code over the course of the trial. These summary statistics can then be recorded and transferred to the main frame computer for subsequent statistical analysis.

Each videotape was coded separately for three types of behaviors. Two of these coding systems involved child behaviors: child attention and child exploration. The third scale assessed the responsiveness of caregiver behavior.

The first coding system, child attention, measured the cumulative duration of the infant's sustained focused attention, in seconds, as it was directed to various aspects of the surroundings. There were four possible behavioral codes determined solely by the focus of the infant's gaze: off-task, social, vision, and vision with manipulation. Offtask was scored only when the infant's gaze was directed away from the toys and from the caregiver to some aspect of the environment or to some point in space. Social was scored only when the infant's attention was focused on the caregiver's face. Look alone was scored when the infant's gaze was directed toward the toy but the infant was not touching it in any manner. Vision with manipulation was coded when the infant touched or manipulated the toy in any manner while looking at it.

The second coding system, child exploration, measured the amount and nature of the infant's manipulation of the toys. In essence, this coding system broke the vision with manipulation category into several more refined subcategories taking into account the nature of the child's manipulatory behaviors. It consisted of eight behavioral categories ranging from simple explorations such as mouthing and banging, to complex explorations taking into account the specific nature and distinctive characteristics of the toy being explored, and to behaviors evidencing task mastery. These eight specific exploratory behavioral codes are listed and described in Appendix C.

The most important behavioral code in this section was focused examination. This was scored only when the child was holding the toy, observing it with an intense expression, while simultaneously fingering its parts or turning it around. Focused examination is a manipulation skill that is also a direct measure of infant focused attention and information processing (Ruff, 1985).

The third coding system was an evaluation of the caregiver's teaching responsivity. This was accomplished through the Caregiver Responsivity Scale, a measure adapted from the University of Washington School of Nursing Child Assessment Satellite Training Teaching Scales (NCAST). This scale assesses caregiver teaching style in interactions with infants between birth and three years. It divides caregiver behavior into four categories: sensitivity to cues, responsivity to distress, socio-emotional growth fostering, and cognitive growth fostering (Barnard, 1978). This scale when given in its entirety by a trained observer has high interrater reliability. Interrater reliability coefficients range from .64 to .86 for each of the four categories, with a median of .82 (Mott, Fewell, Lewis, Meisels, Shonkoff & Simeonsson, 1986). However, this study was interested in only caregiver responsivity behaviors; therefore, only selected items from the instrument were utilized. Reliabilities are not reported for such usage. A copy of the Caregiver Responsivity Scale is included in Appendix A.

Interrater Reliability

Five of the 15 child-caregiver videotapes from each group were independently coded by the researcher and by a second observer. This second observer received prior training in using both the child attention and child exploration category systems, and in using the Teaching Responsivity Scale, but was not informed of the experimental hypotheses or of the children's group membership. Training was conducted using videotapes of children who were pilot subjects for the study.

In order to evaluate rater effects the data from these 20 videotapes were subjected to 4 X 2 (Group X Rater) between and within mixed analyses of variance. The fixed between group variable was Group (Down syndrome, mental-age match, motor-age match, and chronological-age match). The within group variable was Rater, either experimenter or second observer, and this was considered to be a random variable. The advantage of entering

Rater as a random independent variable in an analysis of variance is that it then allows for generalization beyond the two raters in this study to the population of all possible raters. One result of doing this, however, was that quasi F's had to be generated to adequately evaluate the effects of the grouping variable.

If the two raters were consistent with one another and reliable in their coding of behavior then significant Group effects should be found, but significant Group X Rater interactions should not. Obtaining an interaction would imply that the raters coded the groups differently; consequently, there would be unreliability in the coding system. The exact ratings of the two observers are not important in this situation (the Rater main effect), only that the raters are consistent in scoring the occurrences of behaviors in the four groups. It is conceivable that one rater might have held the coding button down consistently longer than the other, or that one rater might have been consistently slower than the other in reacting to the occurrence of the behavior (a Rater main effect). It is expected, however, that both raters coding independently of one another should uncover similar Group main effects.

The 4 X 2 analyses of variance revealed no significant Group X Rater interactions for any of the nine observational dependent variables coded in this study. There were, however, significant Group main effects for social, $\underline{F}(3, 14) = 3.40$, $\underline{p} < .05$; vision alone, $\underline{F}(3, 15) = 8.10$, $\underline{p} < .01$; vision with manipulation, $\underline{F}$(3,

10) = 4.03 $p < .05$; focused examination, $F(3, 16) = 5.66$, $p < .01$; simple exploration, $F(3,16) = 3.19$, $p < .05$; and complex exploration, $F(3, 8) = 16.79$, $p < .01$. There were no significant group effects for Caregiver Responsivity or for mastery. These Group effects will not be discussed here since they parallel the overall study conclusions reported later in the results section. Finding such significant Group effects for both raters in a randomly chosen sample of this small a size is additional support for the robustness of these Group main effects.

There was a significant Rater main effect for vision with manipulation, $F(1, 16) = 5.51$, $p = .032$; focused examination, $F(1, 16) = 9.8$, $p = .007$; and mastery, $F(1, 16) = 20.3$, $p = .0004$. In comparison to the first observer, the second observer consistently saw more focused examination of the toys, more vision with manipulation, and less mastery in each group. The lack of any Rater X Group interactions indicates that both raters were consistent in their scoring of the behaviors occurring across the two groups of children. Estimates of the variance components are provided in Appendix F.

CHAPTER III

RESULTS

The focus of this investigation was on the differences between Down syndrome and normally developing children on each of 11 dependent variables. Eight of these dependent variables were scores obtained from the videotapes of the child's behavior and involved the total amount of time each child spent in 1) offtask, 2) social, 3) vision alone, 4) vision with manipulation, 5) focused examination, 6) simple exploration, 7) complex exploration, and 8) task mastery. All of these variables, with the exception of simple exploration, were obtained by summing the duration of each behavior in each four-minute toy session over all four sessions. Simple exploration was the total of both mouthing and banging behaviors across all four sessions. The remaining three dependent variables consisted of total scores from 9) the Toy Scale, 10) the Infant Intentionality Questionnaire, and 11) the Caregiver Responsivity Scale.

Group Differences

Overall differences between the means for all four groups of children (Down syndrome, motor-age match, mental-age match, and chronological-age match) across all 11 dependent variables were examined initially through a multivariate analysis of variance. This MANOVA revealed a significant overall Group effect for all

11 dependent variables $\underline{F}(33, 136) = 3.76$, $\underline{p} < .0005$. A significant overall Group effect of this magnitude allows for subsequent investigation of each dependent variable separately through analysis of variance.

Eleven separate independent groups one-way analyses of variances (Group) were conducted on each of the 11 dependent variables to determine which of the dependent variables contributed to the overall Group main effect apparent in the MANOVA. There were significant Group differences for eight of the variables: offtask $\underline{F}(3, 56) = 2.92$, $\underline{p} = .042$; social $\underline{F}(3, 56) = 5.54$, $\underline{p} = .002$; vision alone $\underline{F}(3, 56) = 8.34$, $\underline{p} = .0001$; focused examination $\underline{F}(3, 56) = 4.52$, $\underline{p} = .007$; simple exploration $\underline{F}(3, 56) = 6.74$, $\underline{p} = .0006$; complex exploration $\underline{F}(3, 56) = 16.38$, $\underline{p} < .0005$; and for the Infant Intentionality Questionnaire $\underline{F}(3, 56) = 9.47$, $\underline{p} < .0005$. There were no significant Group differences for vision with manipulation, task mastery, the Toy Scale, or the Caregiver Responsivity Scale.

Dunnet's Test For Planned Comparisons

In order to further explore group differences, planned comparisons were conducted on each of the eight dependent variables showing a significant Group effect in the original analysis. Dunnet's tests were computed for offtask, social, vision, focused examination, simple exploration, complex exploration, and intentionality. Dunnet's test is the test of choice whenever pairwise comparisons aare made between one condition and other comparison conditions (Keppel, 1982). It allowed for the detection of specific areas where the Down syndrome children were different from each of the three groups of normally developing children. These results, along with the mean scores of each group on each of the 11 dependent variables are presented in Table 3. Standard deviations for each group on each of the 11 dependent variables are presented in Table 4.

The typical $p < .05$ significance level was selected as a reasonable type 1 error rate for comparisons on each dependent variable. However, since a number of comparisons are made across dependent variables, it is important to also consider a reasonable family-wise error-rate for the 11 dependent variables tested (Keppel, 1982). The Bonferroni (Dunn, 1961; Perlmutter and Myers, 1972) family-wise error-rate corrects for the probablity of getting significant comparisons by chance, solely as a result of the number of comparisons made. In order to maintain a significance level of .05 across tests on 11 dependent variables would require a Bonferroni family-wise error rate of .05/10 = .005. In this study the family-wise error rate of .01 was chosen since this was the closest tabled value to .005.

The Down syndrome children were significantly different from their chronological-age-matched peers in vision alone, simple exploration, complex exploration, and intentionality, with group differences approaching significance for offtask and focused

Table 3

Mean Scores For Each Group on Each Dependent Variable

	Down syndrome	Motor Match	Mental Match	Chronological Match
Offtask 1	36.8	92.4*	80.5+	76.8+
Social	85.9	44.0**	48.4**	75.9
Vision alone	260.1	191.8*	182.9**	139.3**
Vision with Manipulation	443.2	496.0	489.0	523.9
Focused Examination	61.6	114.4**	128.6**	100.3+
Simple Exploration	77.3	99.4	69.6	28.3**
Complex Exploration	40.3	19.7	53.7	133.2**
Mastery	36.0	28.9	34.2	45.0
Toy Scale 2	14.0	12.9	15.0	16.9
Intentionality Questionnaire 3	6.0	4.0**	3.9**	4.0**
Responsivity Scale 4	10.3	10.0	9.3	10.9

Note:
1 All play behavior variables represent average number of seconds.
3 This scale represents the average number of toys in the infant's home.
4 Average score (maximum = 20, minimum = 1) on the responsivity scale.

Note: Dunnet's Planned Comparison Tests were used to test for significant differences between each Down syndrome mean and the means from each group of normally developing children.
** $p < .01$ Significant family-wise comparison. Bonferroni's correction.
* $P < .05$ Significant individual comparison.
+ $p < .10$ Approaches significance at individual comparison level.

Table 4

Standard Deviations For Each Group on Each Dependent Variable

	Down syndrome	Motor Match	Mental Match	Chronological Match
Offtask	33.9	48.6	78	46.1
Social	41.3	27.0	25.5	40.6
Vision alone	93.5	69.6*	53.6	39.3
Vision with Manipulation	109.5	96.4	136.1	82.0
Focused Examination	41.3	63.1	53.7	45.1
Simple Exploration	46.7	52.5	50.3	19.5
Complex Exploration	30.1	17.3	44.0	77.1
Mastery	25.6	17.5	15.6	20.8
Toy Scale	3.5	5.6	5.3	4.2
Intentionality Questionnaire	1.3	1.4	1.3	1.3
Responsivity Scale	5.0	3.3	1.8	2.9

examination. They were not significantly different, however, in social behavior. In comparison to their mental-age-matched peers, the Down syndrome infants were significantly different in social, vision alone, focused examination, and intentionality, with between group differences approaching significance for offtask behavior. There were no significant differences in the amounts of simple and complex exploration in which they engaged. In comparison to their motor-age-matched peers, the Down syndrome infants were significantly different in social, focused examination, and intentionality, with between group differences approaching significance on offtask and vision alone.

As can be seen in Table 3, the Down syndrome children engaged in less offtask behavior, less focused examination and more vision alone than did any group of normally developing children. The Down syndrome children spent significantly more time in social behavior than did either their mental or motor-age-matched peers but they were not significantly different from their chrononlogical-age-matched peers in this behavior. The Down syndrome infants engaged in more simple exploration and less complex exploration than did their chronological-age-matched peers but they were not significantly different from their mental and motor-age-matched peers in this respect. Caregivers were as responsive to the Down syndrome child's behavior and provided as many responsive toys for their play as did caregivers of normally developing children. However, caregivers tended to perceive their Down syndrome infant as being less intentional in their early behaviors than did the caregivers of normally developing children.

Background Variables

In order to ensure that differences between the groups were the result of group membership and were not an artifact of the matching procedure, the infants were also divided into groups according to certain pre-selected background variables. These background variables were then added as additional independent variables in an analysis of variance. The two background variables chosen a priori as being most likely to influence the results were maternal education and birth order. A subsequent 2 X 2 X 4 Analysis of Variance (Education X Birth X Group) was conducted for each of the 11 dependent variables. In essence this 2 X 2 X 4 ANOVA involved a partialling out of the two background effects and seeing if the grouping effect remains. If the matching procedure has been effective and the group differences are real, not an artifact of demographic differences between groups, then separating the Group effect from Birth or Education effects should not change the original Group differences. Thus, it was expected that the orginal Group effects would remain unchanged in this analysis, and that there would not be any Group X Birth or Group X Education interactions. Such interactions would make the Group main effect more difficult to interpret.

An additional advantage of this type of analysis is that it also gives us information about the effects of the demographic variables and their interactions on the dependent variable. This type of information is not available in other types of partialling out analyses (e.g., regression analysis). In this way, the effects that demographic variables such as maternal education and birth order have on the dependent variables, as well as their interactions with one another, can be observed.

Results of the ANOVAs revealed significant group effects for each dependent variable that had been significant in the orginal analysis. In addition, two significant main effects for Education were found for offtask behavior $F(3, 47) = 7.39$, $p = .01$ and, for the Toy scale $F(3, 47) = 8.01$, $p = .007$. Mothers having higher levels of education tended to provide their children with a greater number of responsive toys and had children that spent a greater portion of their time engaged in offtask behaviors than did mothers with lesser amounts of education. One significant Birth X Education interaction was found for simple exploration $F(1, 47) = 4.99$, $p = .03$. Eldest children of highly educated mothers engaged in less simple exploration than did latter born children, while eldest children of less educated mothers engaged in more simple exploration than did later born children. There were no significant group X education or group X birth order interactions.

CHAPTER IV

DISCUSSION

This study has uncovered some important aspects of Down syndrome infants' attention to and exploration of novel objects. In comparison to normally developing infants, infants with Down syndrome spend significantly more time visually attending to toys and significantly less time engaging in offtask behaviors or in focused examination. The Down sydrome infants spent significantly less time in simple and complex exploration than did their chronological-age-matched peers, but their exploration was not significantly differed from normally developing children of similar mental and motor age. Although caregivers of Down syndrome infants perceived their infant as developing intentional behavior later, they provided a similar variety of responsive toys and were as responsive in their teaching behavior as were caregivers of normally developing children. Thus, while both normally developing and Down syndrome infants in this study appear to have access to equally responsive home environments, differences in the Down syndrome infants' behavior, in particular their attentional behavior, may mean that they are less capable of taking full advantage of this information-rich environment.

Visual Attention

In partial support of the first hypothesis, children having Down syndrome spent a greater portion of the play session than did normally developing children in vision alone. This reliance on the visual system occurred despite the fact that these children had the fine motor skills necessary to engage in object manipulation. There were no significant differences among the groups in the amounts of time spent in vision with manipulation.

These differences in visual attention are consistent with previous work and expand on what is already known regarding the attentional and information-processing skills of Down syndrome infants. Earlier studies on visual preferences and recognition memory in very young children with Down syndrome have found that these children spend long periods of time visually fixated on a stimulus presentation (Cohen, 1981; Miranda, 1970; 1976; Miranda & Fantz, 1974). Studies of older Down syndrome children have also found that these children spend more time merely looking at objects and less time in object exploration or mastery than do normally developing children of similar chronological age (Krakow & Kopp, 1983; McTurk et al, 1985; Vietze et al, 1983). Preterm infants expected to show poorer developmental outcomes as the result of neonatal complications also show prolonged visual fixations (Landry, 1986).

These extended periods of visual fixation are significant indicators of impaired developmental progress. Recent investigations have found that prolonged visual fixations in normally developing and in preterm infants are predictive of poorer scores on intelligence tests during the preschool and elementary school years (Columbia, Mitchell, O'Brien & Horowitz, 1987; Slater, 1985; Sigman, Cohen, Beckwith & Parmelee, 1985). At one time it was believed that looking time was directly related to information processing time and that the prolonged visual fixations of the Down syndrome child indicated a need for additional familarization time (Cohen, 1981). This may not be entirely true. It is now known that, in addition to a more focused attentional component, looking time also includes both casual looking and blank staring (Ruff, 1984a). Thus, it is possible that even though the Down syndrome children are looking at the stimuli they are not taking in information throughout that entire period. This could explain why extending the familarization time does not improve recognition performance (Miranda & Fantz, 1974).

The fact that Down syndrome infants did not spend significantly less time in vision with manipulation is intriguing and may be, in part, an artifact of the study design. In this study, vision with manipulation was scored whenever the child was looking at the toy while simultaneously touching it, regardless of the type of manipulation (this was recorded in the exploration scales). Thus, at times vision with manipulation was scored when the child was looking at and touching the toy, while the caregiver was demonstrating it (e.g., the child would be grasping the spinning duck, the caregiver would move the duck back and forth on the table, the child would watch this movement while retaining his or her grasp on the toy). This type of demonstration occurred frequently with some of the Down syndrome children and may have resulted in an overestimation of their vision with manipulation.

In partial support of the second hypothesis, the Down syndrome infants' visual attention tended to remain exclusively focused on the toys with much less attention directed offtask. The Down syndrome children only infrequently engaged in any type of offtask behavior, such as looking around the room or staring at the table. However, this could not entirely be the result of a difficulty in shifting attention; the Down syndrome children had little difficulty disengaging from the toys to attend to their social environment. These children spent as much time as did their chronologically-age-matched peers and significantly more time than did their mental- or motor-age-matched peers in social looks toward the caregiver.

Past research has frequently documented the Down syndrome child's infrequent use of offtask attention, implying that these children are unable to shift attention between stimulus elements (Cohen, 1981; Miranda & Fantz, 1974; Berger & Cunningham, 1981). This study shows that between 11 and 15 months of age children with Down syndrome can make this type of attentional shift if the other stimulus is one that is particularily salient (i.e., their caregiver). This type of attentional control is gradually learned by the normally developing infant within the first few months of life (Posner & Rothbart, 1981). It may be that this skill first emerges in the social sphere and that the Down syndrome child does not easily recognize the importance of monitoring the inanimate environment as well the animate one.

Blakemen & Adamson (1984) and Landry (1986) discuss three developmental stages in the coordination of social attention. Prior to six months of age, infant and caregiver engage in solely dyadic interactions with the emphasis on the caregiver to maintain the interaction. At around six months of age infants turn away from these dyadic interactions to engage in object explorations. However, attention is focused exclusively on the toy and they show little evidence of wanting to share this interaction with their caregiver. This changes toward the end of the first year. At this time, infant-object-caregiver interactions become more triadic. Infants begin to switch their attention between object and caregiver and start to respond to caregiver gestures such as pointing and showing. Studies on infant imitiation have found that these periods of joint caregiver-infant attention provide an effective medium for imitiation of modeled toy behavior (Uzgiris, 1983).

It is interesting that the Down syndrome children do not appear to have difficulty with this type of social attentional shift although they make only infrequent offtask attentional shifts. The ability to shift attention between stimuli is important to developmental progress. A child who has difficulty moving attentional focus from one stimulus to another would experience the environment in a very limited manner (Landry, 1986). This, in turn, would restrict the range of information that he or she could acquire. It may be that the Down syndrome child has difficulty recognizing the importance of environmental monitoring. It may be possible to utilize the Down syndrome child's skill in social caregiver-object attention to foster more sophisticated object-offtask attentional shifts.

Object Manipulation

While the four groups of children did not differ significantly in the total amount of time spent in vision with manipulation, there were important group differences observable in the quality of that manipulation. In partial support of the third hypothesis, significant differences were found between the groups in both simple and complex exploratory behaviors. The scores for the Down syndrome infants fell somewhere between the scores for the mental- and motor-age-matched normally developing children on both simple and complex explorations but were significantly different from only the chronological-age-matched group. The Down syndrome infants engaged in more simple exploration and less complex exploration than did children of the same chronological age.

Overall, the Down syndrome children's exploratory behaviors were not that deviant from those of normally developing children of equivalent developmental ability. This result is not that surprising given that the shift from undifferentiated actions on objects (simple exploration) to specific exploration of object characteristics (complex exploration) constitutes a major advance in cognitive development and a stage transition in sensorimotor intelligence (Piaget, 1952; Uzgiris, 1983).

A strong relationship between exploratory behaviors and concurrent developmental age has been found by other investigators in the literature on normally developing children. Jennings, Harmon, Morgan & Yarrow (1981) report that infants who spent more time in cognitively mature play (complex exploration) had higher concurrent Bayley scores and were more persistent and more successful on structured mastery tests than were those children who spent less time in this type of play. Yarrow, McQuiston, McTurk, McCarthy. Klein & Vietze (1983) found that persistence in effect production and in exploratory behavior at six months of age were significantly positively related to concurrent Bayley MDI but not to 12 month Mental Development Index (MDI) scores. Producing effects with objects and exploring the properties of objects are important ways for interacting with the environment in early infancy and contribute to infant competence at that time; however, they are not as strongly related to future achievement (Yarrow & Messer, 1983)

Since exploratory behavior is clearly tied to developmental level in normally developing children, it is only reasonable to expect that Down syndrome children's exploratory behavior would be more similar to their mental- and motor-age-matched peers than to their chrononological-age-matched peers. In fact, the Down syndrome children in this study did not differ significantly from their mental- and motor-age-matched peers in either the overall quantity or the quality (simple vs complex) of the exploration in which they engaged. The failure of previous studies to include appropriate developmental-age-matched comparison groups may have lead to an overemphasis on the deficiencies of the Down syndrome child in this area.

The fourth hypothesis predicted that when the Down syndrome child's attention was focused by the caregiver on one particular responsive feature of the toy they would be as successful as the normally developing children in mastering the selected task. This hypothesis was supported. There were no significant differences among the four groups of children in their mastery of the demonstrated task.

It is interesting that when the child's attention was specifically directed by the caregiver to one responsive characteristic of the toy, all four groups of children were equally successful in performing the demonstrated task. This suggests that differences among the groups in exploratory behavior were not due to the younger child being unable to perform the exploratory manipulation but that the younger child does not spontaneously engage in this type of behavior. However, they may readily imitate this behavior once it has been demonstrated (Uzgiris, 1983).

In the literature on normally developing children, caregivers who more frequently direct their child's attention to objects and events in the environment have infants who are more advanced in cognitive functioning (Ruddy & Bornstein, 1982), as well as displaying the greatest competence while exploring and examining (Belsky, Goode & Most, 1980; Bornstein & Sigman, 1986; Henderson, 1984; Maslin, Bretherton & Morgen, 1986). Landry, Chapeski & Schmidt (1986) found that it was maternal physical attention focusing (e.g., demonstrating to a child the manner in which an object works or moving the child's hands through the motions of an activity) and not verbal attention focusing (e.g., look, see this) that was most effective in increasing infant manipulation of environmental objects. Presumably this was because it guided the child into manipulations which he or she normally would not produce.

This type of attention focussing may be equally effective for children having Down syndrome. Smith and Hagan (1984) found that those Down syndrome children demonstrating the best developmental progress had caregivers who spoke to them relatively frequently with reference to the environment. In the present study, instructing caregivers to direct infant attention to one exploratory behavior resulted in nonsignificant group differences in the performance of that particular behavior. It may be that training parents of Down syndrome children to direct their child's attention to selected aspects of their environment could also enhance their child's ability to take in and encode that environmental information.

The significant differences found between the Down syndrome and normally developing children in focused examination provided support for the fifth hypothesis. Infants having Down syndrome engaged in much less focused examination than any group of normally developing children. Focused examination is a special form of object manipulation that involves both sustained visual regard and simultaneous tactile exploration. Examination is considered to reflect focussed attention; therefore, it involves active intake of information about the toy and not just activity that happens to include the toy (Ruff, 1986).

The Down syndrome child's deficiency in focused examination may be of major cognitive significance. While looking alone is negatively correlated to five-year IQ scores in normally developing children (Columbia et al., 1987; Ruff, 1985; Slater, 1985; Sigman et al, 1985), duration of focused examination at nine months is positively related with three- and four-year-old IQ scores in normally developing children (Ruff, 1985; 1986). Ruff believes that focused examination is more useful than looking time in judging both the infant's motivation and the infant's ability in gathering information about the environment (Ruff, 1985). Presumably, this is because focused examination provides a rich source of information about the object and because it is a more direct measure of information intake than is looking alone. Looking involves a combination of focused attention, casual looking and blank staring (Ruff, 1986).

During focused examination, as in focused attention, the infant is presumably encoding some type of information about the stimulus, comparing it with existing mental representations, and constructing some trace of the event (Bornstein, 1984; Kessen, Haith & Salapatek, 1970; Sokolov, 1963; 1969). Attention would then remain focused on the object's visual and tactile properties as long as the stimulus and the mental construction are not isomorphic. The length of time spent in focused examination could then be said to represent the period of time during which the trace of the stimulus is being refined to accurately and fully reflect the entire range of object characteristics.

Studies of this process have typically found that those infants who display better recognition memory for a stimulus are faster and more thorough in these information-extraction, comparison, and storing processes (Bornstein & Sigman, 1986; Columbia, Mitchell, O'Brien & Horowitz, 1987). The differences in focused examination found between normally developing and Down syndrome infants in the present study would suggest that Down syndrome children have great difficulty with the information-extraction process. In fact, the reduced duration of focused examination in these children must mean that they have access to much less visual-tactile information than does the normally developing child in the same situation. This may have profound ramifications for their ability to learn from an information-rich environment. The shorter duration of focused examination in the Down syndrome child can be viewed as both an index of the impaired cognitive functioning of these children and a contributing factor in the impairment.

In this study, it is very difficult to separate out a specific visual deficit, from a tactile deficit, or from a difficulty in relating the two modalities. In fact, it is extremely probable that the Down syndrome child's poor performance in focused examination involves components of all three. Henderson (1985) believes that the Down syndrome child has no one specific sensory modality deficiency; instead he feels that there is a poor extraction of sensory information, regardless of modality. The Down syndrome child has a general difficulty deciphering available sensory information. Attempting to take in, compare and integrate two different types of sensory information may be an additional demand. Consequently, it may be easier for the child to retreat to visual intake alone when encountering novel objects. This explanation is consistent with the work of Bradley-Johnson et al (1981) who found that the Down syndrome child's tendency to engage in prolonged visual fixations occurs only with novel stimuli. This explanation is also consistent with the work of Posner and Rothbart (1981) who have postulated that when there is not enough attentional capacity to encode both tactile and visual information, visual information will dominate and will take precedence over tactile information.

At this point it is interesting to make some tenative hypotheses regarding the differences found in attentional but not in exploratory skills. The delays in the Down syndrome children's exploratory behaviors are consistent with and appropriate for children at their present developmental level; the deficiences in their attentional behaviors are not. This reflects findings in the literature on normally developing children that exploratory behavior reflects current cognitive functioning (Jennings et al, 1981; Yarrow et al, 1983), while attentional behavior (including focused examination) is more related to future cognitive functioning (Ruff, 1986). The skill to engage in refined object manipulation is a necessary but not sufficient skill for developmental progress. Object manipulation and exploration are useful as a means for obtaining information from the environment. Cognitive advancement requires, in addition, that the organism be capable of coping with this rich a source of environmental information, taking in, encoding, storing, and retaining, and retrieving it for future usage.

Home Environment

In direct contradiction to the sixth and seventh hypotheses, the Down syndrome children in this study had as many responsive toys in their homes as did the normally developing children, and caregivers were as responsive to the child in their teaching behavior as were caregivers of normally developing children. Attempts to promote optimal cognitive development in handicapped children have typically focused on increasing environmental responsivity (Brinker & Lewis, 1982; Dunst, 1981). However, it has never been adequately demonstrated that it is the child's home environment (and its lack of contingency) that is the major obstacle in the retarded child's developmental progress. These results indicate that these types of environmental manipulations may not be necessary for all families with Down syndrome children.

In this sample of Down syndrome infants involved in a home-based early intervention programme, the Down syndrome child's home environment was no different from that of the normally developing child. One possible reason for the lack of significance on this measure may be the philosophical orientation of the British Columbia Infant Development Programme in which theses families were enrolled. A specific goal of this programme is to support the developing caregiver-child relationship and increase caregiver responsivity to child behavior. In such an optimal home environment further increases in home responsivity may be unnecessary. These results may not be equally applicable to other Down syndrome children not having access to such programmes.

As predicted in the eighth hypothesis, intentional behavior was perceived by caregivers as developing later in Down syndrome children than in normally developing children. It is interesting to note that the mean difference between the group of Down syndrome infants and the normally developing infants on the

Intentionality Scale was only 1.4 months, even though the Down syndrome infants showed a five month delay in motor development and a three month delay in mental development on the Bayley Scales of Infant Development. Thus, despite the significant differences in favor of normally developing children, it may be that caregivers are still perceiving the Down syndrome child's behaviors as more intentional than they are in actuality. This may pose a problem later if the child can not live up to this expectation.

This study's results would caution parents and psychologists against attempting to improve the six to twelve month old Down syndrome child's developmental progress solely by increasing toy and caregiver responsivity. While these are important considerations for developmental progress, having a handicapped child does not automatically mean that more environmental responsivity is required. Infants in this study were provided with a normal quantity of caregiver and toy responsivity, and were perceived by their caregivers as deliberate and intentional in their behavior. These children may now benefit from having parents provide more physical and verbal direction of child attention, having them provide a focus for the child's environmental exploration, and having them provide the child with ample opportunities for more advanced and more complex forms of exploration.

Developmental Model

While the purpose of this present investigation is not to propose possible causal mechanisms for these attentional deficiences, it is interesting to hypothesize about the possible role that early central nervous system immaturities may play in the development of information processing skills. Typically, early information processing is seen as developing out of the newborn's orienting reflex. The initial perception of a stimulus produces a type of general arousal that then directs the infant's attention to the stimulus and prepares the infant for a response. Habituation of this reflex is then a function of the inhibition of this arousal mechanism (Jeffrey, 1976; Lewis, 1971; Posner & Boiss, 1971; Pribram & McGuinness, 1975; Sokolov, 1963; 1969). Specific deficits in arousal or in these inhibitory mechanisms could affect the manner in which this system functions.

As the child begins to pick up and store information--developing stimulus traces, comparing new stimuli with old representations, and refining new traces to accurately reflect the stimulus--an increase and reduction of arousal gradually emerges in association with these processes (Berger & Cunningham, 1981). An optimal amount of arousal is necessary for information processing (Hunt, 1963; Jeffrey, 1976) and the regulation of arousal is necessary in order to initiate, sustain and inhibit attention at the appropriate times (Bornstein &

Sigman, 1986). Control over arousal and over the reception of information occurs in the normally developing child through the use of attentive and nonattentive behavior (Friedman, 1975). It may be that Down syndrome children's prolonged periods of visual fixation, their infrequent looking away behavior, and their lack of focused examination are all indicators of a failure in this arousal mechanism

It is known that the Down syndrome child has a number of early reflexive abnormalities presumably resulting from an immature central nervous system and the late emergence of forebrain inhibitory mechanisms (Henderson, 1985; Berger & Cunningham, 1981). It is also known that an arousal modulation problem exists in children with Down syndrome both in their behavioral reactions to sensory stimulation (Benda, 1969), and their cognitive and behavioral reactions to fearful stimuli (Cicchetti & Sroufe, 1976). It is believed that these children have an immature adrenal system that may not be sufficiently mature over the early years to support full arousal. Either of these could affect the normal working of the mechanisms necessary for the initiation of attention and its habituation.

There are sensitive periods in the young child's life during which time experiences with the environment profoundly affect sensory development, (Mitchell & Timney, 1984). While it appears absurd to design an organism that will be substantially impaired if particular experiences do not occur at particular times, in the long run greater sensory capabilities are possible by loosely programming an organism and using commonly available experiences to detail and refine this program (Greenenough, Black & Wallace, 1987). At the neural level, experiences set synapses that then become committed to particular patterns of organization. Other synapses that could have subserved alternative pathways are then lost. Any deficiences in the Down syndrome child's attentional skills that limits the amount of information taken in would then impair this fine tuning mechanism. It may not be coincidental that autopsies on the brains of young Down syndrome infants typically discover an abnormal quantity of synaptic connections (Marin-Padilla, 1972).

Conclusions and Recommendations

This study developed out of research suggesting that Down syndrome children have a special difficulty processing novel information (Miranda & Fantz, 1974) and literature showing that the deceleration in Down syndrome children's test performance clearly begins in the second half of the first year (Carr, 1970; Dicks-Mireaux, 1972). At the time when developmental progress is minimal in the Down syndrome child, the normally developing child is rapidly learning about the environment; assessing, integrating, and storing information that is then used to guide subsequent learning.

The exploration skills shown by the Down syndrome child are not that deviant from what one would expect in a child of similar developmental age. However, there appear to be significant differences in the information intake component of this exploration (focused examination) and in visual attention. The fact that these deficiencies are so apparent in the behavior of 11- to 15-month-old Down syndrome children, even when compared to normally developing children of similar developmental ability, suggests that they are probably the result of genetic differences in the Down syndrome child. In fact, it is possible that it is through these attentional deficiencies that the genetic mutation expresses its effect on infant learning and on infant development.

This study was exploratory in design and, as such, it has generated a number of topics for future investigation. It is becoming increasingly obvious that a longitudinal replication of this and earlier visual attention research is required in order to fully understand the discrepancies found in the Down syndrome child's perceptual development. It would be most benefical if such a study included measures of both sustained infant attention (e.g. habituation) and infant attentional shifts (e.g., gaze behavior). A comprehensive study of the Down syndrome infant's attention from birth to 12 months of age would require considerable effort but would have the advantage of clearly delineating the changes in perceptual-cognitive skills occurring over time and with increasing exposure to envirnomental stimulation.

A more in-depth investigation of the effects of maternal attention focusing on infant attention is crucial. In particular, the strategies most effective for directing the Down syndrome child's attentional focus need to be examined. This could include an evaluation of the relative effectiveness of physical and verbal techniques, as well as a more thorough investigation of their effects on infant learning.

Replication of this study with other groups of mentally retarded infants is also an important area to pursue. The attentional difficulties experienced by the Down syndrome children in this study may be particular to this syndrome (as result of the extra chromosomal material) or they may be reflective of retarded developmental progress and generalizable to other mentally retarded populations.

REFERENCES

Ainsworth, M. D. S. & Bell, S. (1973). Mother-infant interaction and the development of competence. In K. S. Connolly & J. S. Bruner (Eds.), The Growth of Competence. New York: Academic, 1973.

Anwar, F. (1983a). Vision and kinaesthesis in motor movement. In J. Hogg & P. J. Mittler (Eds.), Advances in Mentally Handicapped Research. Vol. 2. London: Wiley.

Anwar, F. (1983b). The role of sensory modality for the reproduction of shape by the severely retarded. British Journal of Developmental Psychology, 1, 317.

Barnard, K. (1978). Nursing Child Assessment Teaching Scale. Seattle, WA.: University of Washington.

Barnard, K., Bee, H. & Hammond, H. (1984). Home environment and cognitive development in a healthy low-risk sample: The Seattle study. In A. W. Gottfried (Ed.), Home Environment and Early Cognitive Development. New York: Academic.

Barrera, M. E. & Maura, D. (1981). Recognition of mothers photographed faces by the three-month-old infant. Child Development, 52, 714-717.

Bayley, N. (1969). Manual for the Bayley Scales of Infant Development. New York: Psychology Corp.

Beckwith, L & Cohen, S. (1984). Home environment and cognitive competence in preterm children during the first five years. In A. W. Gottfried (Ed.), Home Environment and Early Cognitive Development. New York: Academic.

Belsky, J., Goode, M. K. & Most, R. K. (1980). Maternal stimulation and infant exploratory competence: Cross-sectional, correlational, and experimental analysis. Child Development, 51, 1161-1178.

Benda, C. E. (1969). Down Syndrome. New York: Grune & Stratton.

Berger, J. & Cunningham, C. (1981). The development of eye contact between mothers and normal versus Down syndrome infants. Developmental Psychology, 17, 678-689.

Berger, J. & Cunningham, C. (1983). Early social interactions between infants with Down syndrome and their parents. Health Visitor, 56, 58-60.

Blakeman, R. & Adamson, L. (1984). Coordinating attention to people and objects in maternal-interactions and peer-interactions. Child Development, 55, 1278-1289.

Bornstein, M. H. (1984). Infant attention and caregiver stimulation: Two contributors to early cognitive development. Paper presented at the meeting of the International Conference on Infant Studies, New York.

Bornstein, M. H. & Sigman, M. (1986). Continuity in mental development from infancy. Child Development, 57, 251-269.

Bornstein, M. H. & Tamis, C. (1986). Origins of cognitive skills in infants. Paper presented at the meeting of the International Conference on Infant Studies, Los Angeles.

Bradley, R. & Caldwell, B. (1984). 174 children: A study of the relationship between the home environment and cognitive development during the first five years. In A. W. Gottfried (Ed.), Home Environment and Early Cognitive Development. New York: Academic.

Bradley-Johnson, S., Friedrich, D. D. & Wyrembelski, A. R. (1981). Exploratory behavior in Down syndrome and normal infants. Applied Research in Mental Retardation, 2, 213-238.

Brinker, R. P. & Lewis, M. (1982). Discovering the competent handicapped infant: A process approach to assessment and intervention. Topics in Early Childhood Special Education, 2, 1-16.

Bruner, J. S. (1973). The growth of representational processes in childhood. In J. Anglin (Ed.), Beyond the Information Given. New York: Norton.

Bryant, P. E., Jones, P., Claxton, V. & Perkins, G. M. (1972). Recognition of shapes across modalities. Nature, 240, 303-304.

Butterworth, G. (1983). Structures of the mind in human infants. In L. P. Lipsitt (Ed.), Advances in Infancy Research. Vol. 2. New Jersey.

Butterworth, G. & Cicchetti, D. (1978). Visual calibration of posture in normal and motor-retarded Down syndrome infants. Perception, 7, 513-525.

Butterworth, G. & Hicks, J. (1977). Visual propriorecption and postural stability in infancy: A developmental study. Perception, 6, 255-262.

Caron, A. J., Caron, R. J. & Carlson, V. R. (1978). Infant perception of the invariant shape of an object varing in slant. Child Development, 50, 716-721.

Carr, J. (1970). Mental and motor development in young Mongol children. Journal of Mental Deficiency Research, 14, 205-220.

Cicchetti, D. & Sroufe, L. A. (1976). The relationship between affective and cognitive development in Down syndrome infants. Child Development, 47, 920-929.

Clarke-Stewart, K. A. (1973). Interactions between mothers and their young children: Characteristics and consequences. Monographs of the Society For Research in Child Development, 38 (6-7 Serial No. 153).

Clausen, J. (1968). Behavioral characteristics of Down syndrome subjects. American Journal of Mental Deficiency, 73, 118-126.

Coates, D. L. & Lewis, M. (1984). Early mother-infant interactions and cognitive status as predictors of school performance and cognitive behavior in 6-year-olds. Child Development, 55, 1219-1230.

Cohen, L. B. (1981). Examination of habituation as a measure of aberrant infant development. In S. L. Friedman & M. Sigman (Eds.), Preterm Birth and Psychological Development. New York: Academic.

Columbia, J., Mitchell, W., O'Brien, M. & Horowitz, F. D. (1987). The stability of visual habituation during the first year of life. Child Development, 58, 474-487.

Cook, M., Fields, J. & Griffiths, K. (1979). The perception of solid form in early infancy. Child Development, 49, 866-869.

Connor, F., Williamson, G. & Siepp, J. (1978). Program Guide for Infants and Toddlers with Neuromotor and Other Developmental Disabilities. New York: Teachers College Press.

Cowie, V. A. (1970). A study of the early development of Mongols. Oxford: Pergamon.

Cunningham, C. & Crawley, S. B. (1983). Mother-child interactions involving two-year-olds with Down syndrome: A look at individual differences. Child Development, 54, 1312-1323.

Davidson, P. W., Pine, R., Wilksesketten-Mann, M. & Appelle, S. (1980). Haptic-visual shape matching by mentally retarded children: Exploratory activity and complexity effects. American Journal of Mental Deficiency, 84, 526-533.

Dicks-Mireaux, M. I. (1972). Mental development in infants with Down syndrome. American Journal of Mental Deficiency, 77, 26-32.

Dunn, O. J. (1961). Multiple comparisons among means. Journal of the American Statistical Association, 56, 52-64.

Dunst, C. (1981). Infant Learning. Hingham, MA.: Teaching Resource.

Dunst, C. (in press)Sensorimotor development of infants with Down syndrome. In D. Cicchetti & M. Beeghley (Ed.), The Developmental Perspective. New York: Cambridge University Press.

Easton, T. A. (1972). On the normal use of the reflexes. American Scientist, 60, 591-599.

Easton, T. A. (1978). Co-ordinative structures--the basis for a motor program. In D. M. Landers & Christina, R. W. (Eds.). Psychology of Motor Behavior and Sports. Illonios: Human Kinetics.

Fagan, J. F. (1973). Infants' delayed recognition memory and forgetting. Journal of Experimental Child Psychology, 16, 424-450.

Fagan, J. F., Morrongiello, B. A., Rovee-Collier, C. K. & Gekov, M. J. (1984). Expectancies and memory retrieval in three month old infants. Child Development, 55, 936-943.

Fagan, J. W. & Rovee, C. K. (1976). Effects of quantitative shifts in visual reinforcer on the instrumental response of infants. Journal of Experimental Child Development, 22, 272-281.

Fagan, J. F. & Sheppard, P. A. (1982). Theortical issues in the early development of visual perception. In M. Lewis & L. Taft (Eds.), Developmental disabilities: Theory, Assessment, and Intervention. New York: SP Medical and Scientific Books.

Fantz, R. L. (1970). Visual perception and experience in infancy: Issues and approaches. In F. A. Young & D. B. Lindsley (Eds.), Early Experience and Visual Information Processing in Percepual and Reading Disorders. Washington: Academy of Sciences.

Fantz, R. L. & Fagan, J. F. (1975). Visual attention to size and number of pattern details by term and preterm infants during the first six months. Child Development, 46, 3-18.

Fantz, R. L., Fagan, J. F. & Miranda, S. B. (1975). Early visual selectivity. In L. Cohen & P. Salapatek (Eds.), Infant Perception From Sensation to Cognition. Vol. 1. Basic Visual Processes. New York: Academic.

Friedman, S. B. (1972a). Habituation and recovery of visual response in the alert human newborn. Journal of Experimental Child Psychology, 13, 339-349.

Friedman, S. B. (1972b). Newborn visual attention to repeated exposure of redundant verus "novel" targets. Perception and Psychophysics, 12, 291-294.

Friedman, S. B. (1975). Infant habituation: Process, problem, and possiblity. In N. Ellis (Ed.), Abberrant Development in Infancy: Human and Animal Studies. New York: Halstead.

Friedman, S. B., Bruno, L. A. & Vietze, P. (1974). Newborn habituation to visual stimuli: A sex difference in novelty detection. Journal of Experimental Child Psychology, 18, 242-251.

Friedman, S. B. & Carpenter, G. C. (1971). Visual response decrement as a function of age of human newborn. Child Development, 42, 1967-1973.

Friedman, S. B., Carpenter, G. C. & Nagy, A. N. (1970). Decrement and recovery of response to visual stimuli in the newborn infant. Proceedings of the 78th Annual Convention of the American Psychological Association, 273-274.

Friedman, S. B., Nagy, A. N. & Carpenter, G. C. (1970). Newborn attention: Differential response decrement to visual stimuli. Journal of Experimental Child Psychology, 10, 44-51.

Gibson, D. (1978). Down Syndrome: The Psychology of Mongolism. Cambridge: Cambridge University Press.

Gibson, E. J. & Spelke, E. S. (1983). The development of perception. In J. H. Flavell & E. M. Markman, Handbook of Child Psychology. Vol. 3. New York: Wiley.

Gordon, A. M. (1944). Some aspects of sensory discrimination in Mongols. American Journal of Mental Deficiency, 49, 55.

Gottfried, A. W. (1984). Home environment and early cognitive development: Integration, meta-analysis, and conclusions. In A. W. Gottfried (Ed.), Home Environment and Early Cognitive Development. New York: Academic.

Gottfried, A. W. & Gottfried, A. E. (1984). Home environment and cognitive development of middle-socioeconomic-status families. In A. W. Gottfried (Ed.), Home Environment and Early Cognitive Development. New York: Academic.

Gottfried, A. W., Rose, S. A. & Bridger, W. H. (1977). Cross-modal transfer in human infants. Child Development, 48, 118-123.

Greenenough, W., Black, J. & Wallace, C. (1987). Experience and brain development. Child Development, 58, 539-559.

Haith, M. M. (1980). Rules That Babies Look By: The Organization of Newborn Visual Activity. New York: Erlbaum.

Hayne, H., Rovee-Collier, C & Ferris, E. (1987). Categorization and memory retrieval in three-month-old infants. Child Development, 58, 750-767.

Henderson, B. B. (1984). Parents and exploration: The effect of context on individual differences in exploratory behaviour. Child Development, 55, 1237-1245.

Henderson, S. E. (1985). Motor skill development. In D. Lane & B. Stratford (Eds.), Current Approaches to Down Syndrome. New York: Holt, Rinehart & Winston.

Hofsten, C. Von (1982). Eye-hand coordination in the newborn. Developmental Psychology, 18, 450-461.

House, B. J. & Zeaman, D. (1960). Positive discrimination, learning and intelligence in defectives of low mental age. American Journal of Mental Deficiency, 65, 51.

Hunt, J. McV. (1963). Motivation inherent in information processing and action. In O. J. Harvey (Ed.), Motivation and Social Interaction. New York: Ronald Press.

Hunt, J. McV. (1965). Intrinsic motivation and its role in psychological development. In D. Levine (Ed.), Nebraska Symposium on Motivation. Vol 13. Lincoln: University of Nebraska Press.

Hunter, M. A. & Ames, E. W. (in press). A multifactor model of infant preferences for novel and familar stimuli. Advances in Infant Research. Vol 5.

Jeffrey, W. E. (1976). Habituation as a mechanism for perceptual development. In T. J. Tighe & R. N. Leaton (Eds.), Habituation: Perspectives From Child Development, Animal Behavior, and Neurophysiology. New Jersey: Erlbaum.

Jennings, K. D., Harmon, R. J., Morgan, G. A. & Yarrow, L. J. (1981). Exploration as an index of mastery motivation: Relationship to persistence, cognitive functioning, and environmental measures. Developmental Psychology, 15, 386-394.

Jones, O. H. M. (1977). Mother-child communication with pre-linquistic Down syndrome and normal infants. In H. R. Schaffer (Ed.), Studies in mother-infant interactions. New York: Academic.

Jones, O. H. M. (1980). Prelinquistic communication skills in Down syndrome and normal infants. In T. Field (Ed.), High Risk Infants and Children. New York: Academic.

Karmel, B. Z. & Maisel, E. B. (1976). A neuronal activity model for infant visual attention. In L. B. Cohen & P. Salapatek (Eds.), Infant Perception: From Sensation to Cognition. Vol. 1. New York: Academic.

Kaye, K. (1982). The Mental and Social Life of Babies. Chicago: Chicago University Press.

Keppel, G. (1982). Design and Analyses: A Researchers Handbook. Vol. 2. New Jersey: Prentice-Hall.

Kessen, W., Haith, M. M. & Salapatek, P. H. (1970). Human infancy: A bibliography and guide. In P. H. Mussen (Ed.), Carmichael's Manual of Child Psychology. Vol 1. New York: Wiley.

Kessen, W., Salapatek, P. & Haith, M. (1972). The visual response of the human newborn to linear contour. Journal of Experimental Child Psychology, 13, 9-20.

Komiya, M. (1981). An experimental study of tactile and visual discrimination in children with Down syndrome. Japanese Journal of Special Education, 19, 17-18.

Komiya, M. (1982). An expimental study of tactile and visual discrimination in children with Down syndrome: The variety of discrimination responses effected by different kinds of stimulus presentations. Japanese Journal of Special Education, 20, 2.

Kopp, C. & Parmelee, A. H. (1984). In P. Mussen (Ed.), Handbook of Infant Development. Vol 2. New York: Wiley.

Krakow, J. & Kopp, C. (1983). The effect of developmental delay on sustained attention in young children. Child Development, 54, 1143-1155.

Landry, S. H. (1986). Preterm infants' responses in early joint attention interactions. Infant Behavior and Development, 9, 1-14.

Landry, S. H., Chapeski, L. & Schmidt, M. (1986). Effects of maternal attention-directing strategies in preterms responses to toys. Infant Behavior and Development, 9, 257-269.

Lewis, M. (1971). Individual differences in the measurement of early cognitive growth. In J. Hellmuth (Ed.), Exceptional Infant. Vol 2. New York, Brunner/Mazel.

Lewis, M. & Brooks-Gunn, J. (1984). Age and handicapped group differences in infant visual attention. Child Development, 55, 858-868.

Lewis, V. A. & Bryant, P. E. (1982). Touch and vision in normal and Down syndrome babies. Perception, 11, 691-701.

Lewis, M. & Goldberg, S. (1969). Perceptual cognitive development in infancy: A generalized expectancy model as a function of the mother-infant interaction. Merrill-Palmer Quarterly, 15, 82-100.

Lipsitt, L. P. & Werner, J. S. (1981). The infancy of human learning processes. In E. S. Gollin (Ed.), Developmental Plasticity: Behavioral and Biological Aspects of Variation in Development. New York: Academic.

Loveland, K. (1987). Behavior of young children with Down syndrome before the mirror: Exploration. Child Development, 58, 768-778.

Maccoby, E. M. & Martin, J. A. (1983). Socialization in the context of the family: Parent-child interaction. In P. Mussen (Ed.), Handbook of Child Psychology. Vol 4. New York: Wiley.

Marin-Padilla, M. (1972). Structural abnormalities of the cerebral cortex in humans with chromosomal abnormalities: A golgi study. Brain Research, 44, 625-629.

McCall, R. B. (1974). Exploratory manipulation and play in the human infant. Monographs of the Society For Research in Child Development, 39, (2, Serial No. 155).

McQuiston, S. & Wachs, T. A. (1979). _Developmental changes in the nature of infants' exploratory behavior_. Paper presented at the meeting for the Society For Research in Child Development, San Francisco.

McTurk, R. H., Vietze, P., McCarthy, M., McQuiston, S. & Yarrow, L. J. (1985). The organization of exploratory behavior in Down syndrome and normally developing infants. _Child Development_, _56_, 573-581.

McTurk, R. H. & Yarrow, L. J. (1985). _The Structure of Mastery Motivation in Down Syndrome and Normal Infants_. Paper presented at the meeting of the Society For Research in Child Development.

Milewski, A. (1979). Visual discrimination and detection of configurational invariance in 3-month-old infants. _Developmental Psychology_, _15_, 357-363.

Miranda, S. B. (1970). Response to novel and visual stimuli by Down syndrome and normal infants. _Proceedings of the 78th Annual Convention of the American Psychological Association_, 275-276.

Miranda, S. B. (1976). Visual attention in defective and high-risk infants. _Merrill-Palmer Quarterly_, _22_, 210-228.

Miranda, S. B. & Fantz, R. L. (1973). Visual preference of Down syndrome and normal infants. _Child Development_, _44_, 555-561.

Miranda, S. B. & Fantz, R. L. (1974). Recognition memory in Down syndrome. _Child Development_, _45_, 651.

Mitchell, D. E. & Timney, B. (1984). Postnatal development of function in the mammal nervous system. In F. M. Brookhart & V. R. Mountcastle (Eds.), _Handbook of Physiology, Section 1: The Nervous System_. _Vol 3_. Bethesda, MD: American Physiological Society.

Moress, J. R. (1984). Cognitive development in Down syndrome and normal infants: Slow or different. _British Journal of Educational Psychology_, _53_, 40-43.

Mott, S., Fewell, R., Lewis, M., Meisels, K., Shonkoff, J. & Simeonsson, R. (1986). Methods for assessing child and family outcome in early childhood special education programs: Some views from the family. _Topics in Early Childhood Special Education_, _6_, 1-15.

O'Connor, N. & Hermelin, B. (1961). Visual and sterognostic shape recognition in normal children and mongol and non-mongol imbeciles. Journal of Mental Deficiency Research, 5, 63-66.

Olson, G. M. (1976). An information processing analysis of visual memory and habituation in infants. In T. J. Tighe & R. N. Leaton (Eds.), Habituation: Perspectives From Child Development, Animal Behavior and Neurophysiology. New Jersey: Erlbaum.

Olson, G. M. (1979). Infant recognition memory for briefly presented visual stimuli. Infant Behavior and Research, 2, 123-134.

Olson, G. M. (198[illegible]). The recognition of specific persons. In M. E. Lamb & L. R. Sherrod (Eds.), Infant Social Cognition: Empirical and Theoritical Considerations. New Jersey: Erlbaum.

Olson, G. M. & Sherman, T. (1983). Attention, learning and memory in infants. In M. Haith & J. Campos (Eds.), Manual of Child Psychology. Vol 2. New York: Wiley.

Olson, G. M. & Strauss, M. S. (1984). In M. Moscovitch (Ed.), Advances in the Study of Communication and Affect. Vol 19. Infant Memory. New York: Plenum.

Parmelee, A. H. (1974). Ontogeny of sleep patterns and associated periodicity in infants. In F. Falkner, N. Kretchmer & E. Rossi (Eds), Modern Problems in Pediatrics. Vol 13. Basel; Karger.

Parmelee, A. H. & Stern E. (1972). Development of states in infants. In C. D. Clemente, D. P. Purpura & F. E. Mayer (Eds.), Sleep and the Maturing Nervous System. New York: Academic.

Perlmutter, J. & Myers, J. L. (1972). A comparison of two procedures for testing multiple contrasts. Psychological Bulletin, 79, 181-184.

Piaget, J. (1952). The Origins of Intelligence in Children. New York: Norton.

Piper, M. C. & Ramsey, M. K. (1980). Effects of early home environment on the mental development of Down syndrome children. American Journal of Mental Deficiency, 85, 39-44.

Posner, M. I. & Boiss, S. J. (1971). Components of attention. Psychological Review, 78, 391-408.

Posner, M. I. & Rothbart, M. K. (1981). The development of attentional mechanisms. In H. E. Howe, Jr. (Ed.), The Nebraska Symposium on Motivation. Nebraska: University of Nebraska Press.

Pribram, M. I. & McGuinness, D. (1975). Arousal, activation and effort in the control of attention. Psychological Review, 82, 116-148.

Pueschel, S. M. (1984). The Young Child With Down Syndrome. New York: Hunar Sciences.

Riksen-Walraven, M. J. (1979). Effects of caregiver behavior on habituation rate and self-efficacy in infants. International Journal of Behavior Development, 1, 105-130.

Rose, S. A., Gottfried, W. A. & Bridger, W. H. (1981a). Cross-modal transfer and information processing by the sense of touch in infancy. Developmental Psychology, 17, 90-98.

Rose, S. A., Gottfried, W. A. & Bridger, W. H. (1981b). Cross-modal transfer in six-month-old infants. Developmental Psychology, 17, 661-669.

Rose, S. A., Gottfried, W. A. & Bridger, W. H. (1983). Infant cross-modal transfer from solid objects to graphic representations. Child Development, 54, 686-695.

Rose, S. A., Gottfried, A. W., Melloy-Carminar, P. & Bridger, W. H. (1982). Familiarity and novelty preferences in infant recognition memory: Implications for infant processes. Developmental Psychology, 18, 704-713.

Rovee, C. K. & Rovee, D. T. (1969). Conjugate reinforcement of infant exploratory behavior. Journal of Experimental Child Psychology, 8, 33-39.

Rovee-Collier, C., Sullivan, M., Enright, M, Lucas, D. & Fagan, J. (1980). Reactivation of infant memory. Science, 208, 1159-1161.

Rubenstein, J. (1967). Maternal attentiveness and subsequent exploratory behavior in the infant. Child Development, 38, 1089-1100.

Ruddy, M. & Bornstein, M. (1982). Cognitive correlations of infant attention and maternal stimulation over the first year of life. Child Development, 53, 183-188.

Ruff, H. A. (1984a). Infant's manipulatory exploration of objects: Effects of age and object characteristics. Developmental Psychology, 20, 9-20.

Ruff, H. A. (1984b). An ecological approach to infant memory. In M. Moscovitch (Ed.), Infant Memory: Its Relation to Normal and Pathological Memory in Humans and Other Annimals. New York: Plenum.

Ruff, H. A. (1985). The Measurement of Attention in High Risk Infants. Paper presented at the meeting of the Society For Research in Child Development.

Ruff, H. A. (1986). Components of attention during infant manipulative exploration. Child Development, 57, 105-114.

Ruff, H. A. & Kochler, C. J. (1978). Tactile-visual transfer in six-month-old infants. Infant Behavior and Development, 1, 258-264.

Salapatek, P. (1975). Pattern perception in early infancy. In L. B. Cohen & P. Salapatek (Eds.), Infant Perception: From Sensation to Cognition. Vol 1. New York: Academic.

Sameroff, A. J. & Cavanagh, P. J. (1979). Learning in infancy: A developmental perspective. In J. D. Osofsky (Ed.), Handbook of Infant Development. New York: Wiley.

Siegel, L. (1965 NORC). Prestige. In R. Hauser and D. Featherman (Eds.) The process of stratification. New York: Academic.

Siegel, L. (1984). Home environment influences on child development in preterm and full-term children during the first five years. In A. W. Gottfried (Ed.), Home Environment and Early Cognitive Development. New York: Academic.

Sigman, M., Cohen, S., Beckwith, L & Parmelee, A. (1985). Infant Attention in Relation to Intellectual Ability in Childhood. Paper presented at the meeting of the International Society For the Study of Behavioural Development, Tours.

Siqueland, E. R. & Delucia, C. A. (1969). Visual reinforcement of non-nutritive sucking in human infants. Science, 165, 1144-1146.

Skinner, E. A. (1985). Sensitive and contingent-response behavior: The role of childrearing beliefs and socioeconomic status. In I. E. Siegel (Ed.). Parental Belief Systems: The psychological consequences for children. New Jersey: Erlbaum.

Slater, A. (1985). The Relationship Between Infant Attention and Learning, and Linguistic and Cognitive Abilities at 18 Months and 4.5 Years. Paper presented at the meeting of the International Society for the Study of Behavioural Development, Tours.

Slater, A., Morrison, V., & Rose, D. (1982). Visual memory at birth. British Journal of Psychology. 73(4), 519-525.

Smith, L. & Hagan, V. (1984). Relationship between the home environment and sensorimotor development of Down syndrome and nonretarded infants. American Journal of Mental Deficiency, 89, 124-132.

Sokolov, E. (1963). Perception and the Conditioned Reflex. New York: MacMillan.

Sokolov, E. (1969). The modeling properties of the nervous system. In M. Coles & I. Maltzman (Eds.), A Handbook of Contemporary Soviet Psychology . New York: Basic.

Stratford, B. (1980). Preferences in attention to visual cues in Down syndrome and normal infants. Journal of Mental Deficiency Research, 24, 57.

Sullivan, M. W., Rovee-Collier, C. K. & Tynes, D. M. (1979). A conditional analysis of infant long-term memory. Child Development, 50, 152-162.

Thelen, E. & Fischer, D. M. (1982). Newborn stepping: An explanation for a "disappearing" reflex. Developmental Psychology, 18, 760-775.

Thelen, E., Kelso, S. & Fogel, A. (1987). Self-organizing systems and infant mental development. Developmental Review, 7, 39-65.

Trevarthen, C. (1982). Basic patterns of psychogenetic change in infancy. In T. G. Bever (Ed.), Regression in Mental Development. New Jersey: Erlbaum.

Uzgiris, I. (1977). Plasticity and structure: The role of experience in infancy. In I. C. Uzgiris & F. Weizmann (Eds.), The Structuring of Experience. New York: Plenum.

Uzgiris, I. (1983). Organization of sensorimotor intelligence. In M. Lewis (Ed.), Origins of Intelligence (2nd Edition). New York: Plenum.

Vietze, P. M., McCarthy, M., McQuiston, S., McTurk, R. & Yarrow, L. (1983). Attention and exploratory behavior in infants with Down syndrome. In T. Field & A. Sostek (Ed.), Infants Born at Risk: Perceptual and Physical Processes. New York: Grune & Stratton.

Wachs, T. D. (1976). Utilization of a Piagetian approach to the investigation of early experience effects: A research strategy and some illustrative data. Merrill-Palmer Quarterly, 22, 12-30.

Wachs, T. D. (1979). Proximal experience and early cognitive-intellectual development. Merrill-Palmer Quarterly, 25, 3-41.

Wachs, T. D. (1984). Proximal experience and early cognitive-intellectual development: The social environment. In A. W. Gottfried (Ed.), Home Environment and Early Cognitive Development. New York: Academic.

Wachs, T. D. & Gruen, C. (1982). Early Experience and Human Development. New York: Plenum.

Wagner, S. H. & Sakovitch, L. J. (in press). A process analysis of infant visual and cross-modal recognition memory: Implications for an amodal code. Advances in Infancy Research.

White, R. W. (1959). Motivation reconsidered: The concept of competence. Psychological Review, 66, 297-333.

Yang, R. & Bell, R. (1975). Assessment of infant intelligence. In P. McReynolds (Ed.), Advances in Psychological Assessment. Vol 3. San Francisco: Jossey-Bass.

Yarrow, L. J., McQuiston, S., McTurk, R. H., McCarthy, M. H., Klein, R. P. & Vietze, P. M. (1983). The assessment of mastery motivation during the first year of life. Developmental Psychology, 19, 159-171.

Yarrow, L. & Messer, D. (1983). Motivation and cognition in infancy. In M. Lewis (Ed.), Origins of Intelligence (2nd Edition). New York: Plenum.

Yarrow, L. J., Rubenstein, J. L. & Pederson, F. A. (1975). Infant and Environment. New York: Wiley.

Yarrow, L. J., Rubenstein, J. L., Pederson, F.A. & Jankowski, J. J. (1972). Infant Environment: Early Cognitive and Motivation Development. Washington, D. C.: Wiley.

Young-Brown, G., Rosenveld, H. M. & Horowitz, F. (1977). Infant discrimination of facial expression. Child Development, 48, 555-562.

APPENDICES

APPENDIX A

Child's Toy Environment Interview

A. Sensory Toys
1. texture blanket
2. poke and feel box
3. puzzle box
4. play dough
5. other_____

B. Shaking and Banging Toys
1. rattles
2. activity center
3. music box
4. drums or other musical instruments
5. other_____

C. Batting Toys
1. roly-poly toy
2. chime ball
3. spinning balls
4. other_____

D. Eye-Hand Coordination Toys
1. beads to string
2. shape sorter
3. pegboards
4. peg and hole toy (e.g., men in tub toy)
5. objects in carton toy (e.g., eggs, milk bottles)
6. buckets to empty
7. other_____

E. Eye-Hand Coordination Toys That Permit Combinations
1. stacking or nesting cups
2. blocks or building toys (e.g., Lego)
3. peg with rings
4. other_____

F. Large Muscle Toys: Hands and Arms
1. cradle gym
2. hammer
3. trucks
4. push or pull toys
5. other_____

G. Large Muscle Toys: Legs
1. jolly jumper
2. walker
3. kiddie car or scooter
3. other_____

H. Imaginative Play
1. child version of adult object (e.g., telephone, dishes)
2. dress up clothes
3. other_____

I. Quiet Activities
1. books
2. puzzles
3. other______
J. Other

Child Effectance Interview

At what age do you think that your child did/ does/ or will do the following:

	age in months
1. Begin to cry solely to gain your attention.	0--3--6--9--12--15--18--21--24
2. Enjoy playing with toys or objects.	0--3--6--9--12--15--18--21--24
3. Communicate by sounds other than crying.	0--3--6--9--12--15--18--21--24
4. Show enjoyment of your play together.	0--3--6--9--12--15--18--21--24
5. Anticipate that other adults should smile and talk to him/her.	0--3--6--9--12--15--18--21--24
6. Become interested in his/her surroundings.	0--3--6--9--12--15--18--21--24
7. Let you know his/her needs nonverbally.	0--3--6--9--12--15--18--21--24
8. Show excitement at having done some activity on his/her own.	0--3--6--9--12--15--18--21--24
9. Smile because he/she recognizes you.	0--3--6--9--12--15--18--21--24
10. Cry in order to have you come to him/her.	0--3--6--9--12--15--18--21--24
11. Show frustration at not being able to get something that he/she wants.	0--3--6--9--12--15--18--21--24

At what age does/ did/ or will it become important for you to:

	age in months
1. Talk to your infant.	0--3--6--9--12--15--18--21--24
2. Praise your child's efforts.	0--3--6--9--12--15--18--21--24
3. Play with your infant.	0--3--6--9--12--15--18--21--24
4. Encourage your infant's curiosity.	0--3--6--9--12--15--18--21--24
5. Stop responding to your infant.	0--3--6--9--12--15--18--21--24

6.	Provide interesting toys or objects for your child's play.	0--3--6--9--12--15--18--21--24
7.	Let your child attempt something even when you are sure that he/she will fail.	0--3--6--9--12--15--18--21--24
8.	Play games with your child.	0--3--6--9--12--15--18--21--24

What do you consider to have been/ or will be your child's first major achievement?____________________________________

At what age did this/ or do you expect this to occur? __________

Videotaped Coding Sheet I
Caregiver Responsivity Questionnaire
(adapted from U of W Nursing Child Assessment Teaching Scale)

1. Parent positions child so that eye to eye contact is possible.
2. Parent gets the child's attention before beginning task.
3. Parent gives instructions only when the child is attentive.
4. Parent allows non-task manipulation of the material after demonstration.
5. After giving the demonstration, parent allows at least 5 seconds for the child to attempt the task before intervening again.
6. Parent uses explanatory verbal style more than imperative style in teaching child.
7. Parent's instructions are in clear, unambiguous language (e.g., "turn the knob toward me" instead of "turn").
8. Parent uses both verbal descriptions and modeling simultaneously in teaching the task.
9. Parent responds to the child's vocalizations with a verbal response.
10. Parent nods or smiles after child has performed better or more successfully than the last attempt.
11. Parent verbally praises child after he/she has performed better or more successfully than the last attempt.
12. Parent changes position of child and/or materials after unsuccessful attempt by the child to do the task.
13. Parent does not physically force the child to complete the task.
14. Parent does not make critical or negative comments about the child's task performance.
15. Parent laughs or smiles at child during the teaching session.
16. Parent smiles or touches child within 5 seconds when child smiles or vocalizes.
17. Parent praises child's efforts or behaviors in a general sense at least once during the episode.
18. Parent makes constructive or encouraging statement to the child during the teaching interaction.
19. Parent's speech is distinct, clear and audible.
20. Parent pays more attention to child during the teaching interaction than to other people or things in the environment.

Appendix B

Caregiver Instructions for Toys

These are four toys that do a number of different things. I want you to show your child everything that each toy does and teach the child one particular developmental task designed specifically for each toy. I am interested primarily in how children of your child's age play with these toys. There are no right or wrong ways to play with each toy. Demonstrate each toy and its task to your child and then allow the child to play with the toy in whatever mannner he or she wishes.

1. Duck on Moving Base: This is a Duplo toy. That means that it comes apart and can be put back together. You can shake it and the toy rattles. The duck's head can be turned around and it makes a clincking noise. The balls can be spun and they change color. When the toy is put together, you can make it move on the bottom wheels, either back and forth or in a circle. I want you to show the child all the things which this toy does and I also want you to show him or her how to make it move. The developmental task for this toy is to make it move on the table top.

2. Turtle and Plexi-glass: This is a soft squeezable turtle. It makes noises very easily. You can squeeze it like this or pat it like this and it will squeek and jump around on the table. Young children also like to put it in their mouths and bite it. The developmental task for this toy is to get the toy from behind this plexi-glass barrier. You put it behind the barrier like this and show your child how to reach around the side or over the top to obtain the turtle. If they still cannot obtain it, you may give it to them for the last two minutes of play.

3. Ball and Cloth: This is a clear plexi-glass ball with water in it and with ducks floating in that water. When you shake it, the ducks move about and make noises as they hit the side of the glass. It also rolls very easily across the table. The developmental task for this toy is to place the ball on the scarf so that your child cannot reach the ball but can pull the cloth to obtain it. Again, if he or she has difficulty getting the toy on his or her own you may show them again. They may be given the ball after two minutes of attempting to gain it without success.

4. Horse: This is another Duplo toy that can be taken apart and put back together. The horse rattles when it is shaken. There

are knobs that can be turned and balls that can be spun. The horse's head and tail move up and down. When the horse is put on the base like this it can be pulled across the table and the head and tail move. When it is placed on the base this way the entire horse rocks. The developmental task for this toy is to make the horse rock.

Please, be as natural as possible in your interactions with your child. If you feel you need to redemonstrate a toy or task you may do so. Remember, I am not concerned so much in whether your child can do the task as in what he or she does decide to do with the toy.

Appendix C

Exploratory Behavior Codes

1) reject, which occurred when the infant pushed the toy away and refused to interact with it.
2) holding, which consisted of the infant passively holding the object in his/her hand without making any attempt at manipulation and without any intense regard.
3) mouthing, which was the total duration of time the infant spent with the toy in his/her mouth.
4) banging, which was scored when the toy was moved in an up-down motion making a definite noise when it made contact with the table.
5) game, which was social in nature and was scored when the infant engaged the mother in a repeated sequence of actions such as rolling the ball back and forth or dropping a toy repeatedly.
6) focused examination, which occurred specifically when the infant was holding the object, observing it with an intense regard, while simultaneously fingering its parts or turning it around.
7) complex exploration, which was a global category that included all infant behaviors adapted specifically to the toy being manipulated but not including the demonstrated toy task (e.g., squeezing the turtle, shaking the ball, moving the horse's head up and down, or pulling apart the sections of the duck).
8) mastery behavior, which occurred only when the infant engaged in the one behavior the parent was to have taught the child (e.g., pulling the cloth to obtain the ball, reaching around the barrier to grab the turtle).

Appendix D

Manova and Anova Group Differences on Each Dependent Variable

Source	SS	MS	F	df	p
ALL			3.76	33, 136	.0005
Responsitivity	31.6	10.6	1.2	3, 56	ns
Toys	138.5	46.1	1.80	3, 56	ns
Intentionality	49.4	16.5	9.47	3, 56	.00005
Off-task	25963.3	8654.4	2.92	3, 56	.0421
Social	19563.9	6521.3	5.54	3, 56	.0029
Vision	112607.0	37535.8	8.34	3, 56	.0001
Vision with Manipulation	50376.9	16792.3	1.44	3, 56	ns
Focused Examination	35938.3	11979.4	4.52	3, 56	.0067
Simple Exploration	39698.7	13232.9	6.74	3, 56	.0006
Complex Exploration	111552.0	37184.0	16.38	3, 56	.00005
Mastery	2095.4	698.5	1.71	3, 56	ns
Error					
Responsivity	495.2	8.8			
Toys	1438.1	25.6			
Intentionality	97.3	1.7			
Off-task	166216.5	2968.2			
Social	65949.4	1177.7			
Vision	252038.9	4500.7			
Vision with Manipulation	651229.9	11629.1			
Focused Examination	148439.6	2650.7			
Simple Exploration	109877.0	1962.1			
Complex Exploration	127110.3	2269.8			
Mastery	22926.9	409.4			

Appendix E

Group X Birth Order X Education Background ANOVA:
Significant Main Effects and Interactions

Source	SS	MS	F	df	p
Toy					
Education	183.2	183.2	8.01	1, 47	.0068
Intentionality					
Group	32.8	10.9	6.09	3, 47	.0014
Off-task					
Group	27026.1	9008.7	3.58	3, 47	.0207
Education	18608.2	18608.2	7.39	1, 47	.0092
Social					
Group	23902.5	7967.5	7.06	3, 47	.0005
Vision					
Group	91979.7	30659.9	7.08	3, 47	.0005
Focused Examination					
Group	29821.5	9940.5	3.42	3, 47	.0250
Simple Exploration					
Group	43939.1	14646.4	7.82	3, 47	.0002
Birth X Educ	9344.2	9344.2	4.99	1, 47	.0300
Complex Exploration					
Group	55333.4	18444.5	9.15	3, 47	.0001

Appendix F

Reliability for Offtask

Source	SS	MS	F	df	p
Group	14903.1	4967.7	1.82	3, 16	ns
Error (S/G)	43683.1	2730.2			
Quasi F			1.70	3, 17	ns
Rater	.0	.0	0.00	1, 16	ns
R X G	846.1	282.0	2.67	3, 16	ns
Error (SR/G)	1692.3	105.8			

<u>Variance Estimates</u>

Group = 8670.7
Group X Rater = 264.3
Rater = -5.3
Subjects/Groups = 1312.2
Subjects X Raters/Groups = 105.8

Reliability for Social

Source	SS	MS	F	df	p
Group	23732.5	7910.8	3.34	3, 16	.048
Error (S/G)	37879.6	2367.5			
Quasi F			3.40	3, 15	.05
Rater	9.5	9.5	0.04	1, 16	ns
R X G	599.5	199.8	0.77	3, 16	ns
Error (SR/G)	4154.7	259.7			

Variance Estimates

Group = 420.3
Group X Rater = -9.0
Rater = -12.5
Subjects/Groups = 1053.9
Subjects X Raters/Groups = 259.7

Reliability for Vision Alone

Source	SS	MS	F	df	p
Group	181726.1	60575.4	8.04	3, 16	.002
Error (S/G)	120486.2	7530.4			
Quasi F			8.10	3, 15	.01
Rater	2129.8	2129.8	2.86	1, 16	ns
R X G	2069.8	689.9	.93	3, 16	ns
Error (SR/G)	1692.3	105.8			

Variance Estimates

Group = 3982.4
Group X Rater = 8.1
Rater = 69.3
Subjects/Groups = 3393.0
Subjects X Raters/Groups = 743.6

Reliability for Vision with Manipulation

Source	SS	MS	F	df	p
Group	145825.1	48608.4	3.35	3, 16	.045
Error (S/G)	232177.4	14511.1			
Quasi F			4.03	3, 10	.05
Rater	19827.8	19827.8	5.51	1, 16	.032
R X G	3459.8	1153.3	0.32	3, 16	ns
Error (SR/G)	57617.7	3601.1			

<u>Variance Estimates</u>

Group = 2740.8
Group X Rater = 367.2
Rater = 811.3
Subjects/Groups = 5455.0
Subjects X Raters/Groups = 3601.0

ρ

Reliability for Simple Exploration

Source	SS	MS	F	df	p
Group	49367.2	16455.7	3.30	3, 16	.047
Error (S/G)	79725.6	4982.8			
Quasi F			3.19	3, 16	.05
Rater	259.1	259.1	1.48	1, 16	ns
R X G	1044.5	348.2	1.98	3, 16	ns
Error (SR/G)	2806.8	175.4			

Variance Estimates

Group = 847.5
Group X Rater = 25.9
Rater = 4.2
Subjects/Groups = 2403.2
Subjects X Raters/Groups = 175.4

Reliability for Complex Exploration

Source	SS	MS	F	df	p
Group	55026.9	18342.3	12.69	3, 16	.0002
Error (S/G)	23134.8	1445.9			
Quasi F			16.79	3, 8	.01
Rater	372.7	372.7	0.73	1, 16	ns
R X G	476.3	158.8	0.31	3, 16	ns
Error (SR/G)	8199.5	512.5			

Variance Estimates

Group = 1293.7
Group X Rater = -53.0
Rater = -7.0
Subjects/Groups = 466.7
Subjects X Raters/Groups = 512.5

Reliability for Focused Examination

Source	SS	MS	F	df	p
Group	81440.1	27146.7	5.74	3, 16	.007
Error (S/G)	75625.8	4726.6			
Quasi F			5.66	3, 16	.01
Rater	3820.0	3820.0	9.79	1, 16	.007
R X G	1375.3	458.4	1.17	3, 16	ns
Error (SR/G)	6244.3	390.3			

Variance Estimates

Group = 1676.4
Group X Rater = 10.2
Rater = 171.5
Subjects/Groups = 2168.3
Subjects X Raters/Groups = 390.3

Reliability for Caregiver Responsivity

Source	SS	MS	F	df	p
Group	38.9	13.0	1.44	3, 16	ns
Error	143.6	9.0			
Quasi F0.93, 8ns					
Rater	.1	.1	0.03	1, 16	ns
R X G	24.1	8.0	2.75	3, 16	ns
Error (SR/G)	46.8	2.9			

Variance Estimates

Group = -.075
Group X Rater = .125
Rater = -.14
Subjects/Groups = 3.0
Subjects X Raters/Groups = 2.9