OPINION

Learning to Look: Cognitive Aspects of Visual Attention

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Abstract

Early visual orienting responses can be prevented in infants with central nervous system damage. Children who have extensive damage in the visual system may ignore whatever visual stimuli they receive. Other children who have a viable visual system may receive the stimuli, but have difficulty with perceiving, interpreting or acting on incoming stimuli. If experience is lacking, visual behavior may never develop. The development of visual pathways seems to depend on experience as well as physiological factors. Intervention must be planned to help multihandicapped children integrate what they see with what they know. Where there is a deficit in the sensory mechanism, repeated stimulation is necessary in order for the brain to receive and process visual stimuli. Visually impaired multihandicapped children do learn to visually attend and process visual information.

Abrégé

Des anomalies du système nerveux central peuvent entraver le développement de la motilité oculaire chez un bébé. Si les lésions sont sévères ou répandues dans le système visuel, l'enfant peut ignorer tout stimulus visuel. Certains enfants avec un système visuel intégral peuvent manifester de la difficulté à perçevoir, interpréter ou à réagir au stimulus. Le développement du système visuel dépend sur l'expérience visuel aussi bien que sur des facteurs physiologiques. Un programme planifié aux besoins de l'enfant souffrant d'handicaps multiples est essentiel pour que l'enfant puisse faire la concordance entre ce qu'il perçoit et ses connaissances. Là où il existe une déficience sensorielle un stimulus prolongé et repété est nécessaire pour que le cerveau reçoive et interprète le stimulus. Les enfants souffrant de handicaps multiples, inclus le plan visuel, peuvent apprendre à répondre au stimulus visuel et interpréter l'information.

Introduction: The Problem

Visually impaired children with neurological/physical handicaps present confusing problems to their parents, physicians and teachers. Because they do not meet the "normal" criteria when judged by the same framework used for assessment in normal development, these children are very often judged to be severely and profoundly mentally handicapped. Yet, we have seen and worked with children who are blind or partially sighted with severe neurological and physical disabilities, who began at the ages of four, five or six, to demonstrate an intelligence capable of learning abstract and symbolic material. Once language is established, many of these children prove capable of academic learning. Some children become quite capable visually and demonstrate far more visual function than could have been predicted from their visual behavior in infancy.

It is our contention that those visual behaviors that have become the parameters of measurement of visual function are, in large part, learned. Visual behaviors which express intention and purpose, such as visual attention, gaze, search, recognition of human faces and familiar objects, and eye and hand coordinated movements, represent a visual system that is well organized and integrated with other body/mind systems, such as language, emotional expressivity, etc.. Visual attention, discrimination, imagery and memory are the products of many experiences based on the physiological capacity of the eye to receive stimuli. The perception of meaning from the light patterns focussed upon the retina depends upon the capacity of the brain to process the light patterns carried by nervous energy through the visual pathways of the brain. The work of Hyvärinen and Hyvärinen (1982) suggests that early visual deprivation may lead to a decrease in the representation of vision in the associative systems of the brain. This may lead to an inability of the neural tissue to make

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normal use of visual signals (Hyvärinen and Hyvärinen, 1982). Work with cats and monkeys indicates that cells in the visual cortex do not develop normally when the animal is given abnormal visual experience during a specific period of early development (Hirsch and Spinelli, 1971, cited by Lockman, 1982). A period of abnormal visual experience early in human experience can result in lower than normal acuity levels in adulthood (Lockman, 1982).

The effects of visual impairment on the development of multihandicapped children interfere with the development of body/mind systems. Van Dijk (1982) found these effects to be greater than other variables such as hearing impairment or low birthweight. Deprivation of visual stimulation imposes many constraints on the child as he attempts to cope with the external environment. The irony is that many of these children appear to function as if they were blind, and give little indication of responding to visual stimuli they do receive. It is extremely important for the futures of these children that efforts be made to assess and develop their visual functioning, and that they not be considered blind in the absence of functional eye disease. Multiply-handicapped children with damage to the visual system are at a critical disadvantage. Not only do they experience reduced input through their other senses, but when they are kept on their backs in a bed or crib, or in one position in a room, they have extremely limited exposure to visual stimuli. Lack of practice in ocular and motor activity further inhibits any development of vision. The child becomes locked into a vicious cycle. Reduced vision produces reduced output and creates a deprived and depriving environment that is further exacerbated when there is no expectation that the child will improve. Then, there is even less opportunity created for those necessary interactions which stimulate visual responses and in turn reduces what may be available to the child in the way of visual input leading to a dramatic lack of development.

This pattern can be broken and learning to "look" and then "looking to learn" can be developed in multiply-impaired children. Visually impaired multihandicapped children are rarely totally blind. Most of these children possess visual potential but lack the experience necessary to develop behaviors that will demonstrate it. With prompt and careful attention from the optometrical and medical professions, especially optometrists and ophthalmologists, and careful intervention based on sound pedagogical principles, severe and profound retardation and visual avoidance may be prevented in most of these children. Profound retardation is frequently a secondary handicap arising from neglect and lack of early intervention.

Vision in Normal Development

In the normally developing child, vision appears to develop spontaneously. Vision becomes well organized and integrated with other sense modalities as the child interacts with his environment. Visual attention can be observed in very young infants (2 months of age) and visual search is seen as early as three months (Tronick and Adamson, 1980). The fact that these behaviors are developed so early in normal infants has led to the belief that they are physiologically scheduled. From the beginning the normal infant is oriented towards looking. His brain seeks stimulation and the visual system is oriented to produce looking behaviors. Normal infants do not need to be "taught" to see. No one shows the infant how to "look" at his or her mother's face or focus his/her eyes upon an object. By six months of age, the infant is actively using his eyes to explore his environment, his visual memory is well developed, and he has integrated his/her vision with communicating and interacting with his/her environment.

Because of the importance of vision in integrating with other sense modalities, vision plays a critical role in social, cognitive and language development. From earliest infancy, the eyes function in association with everything that is happening to and around the child. Infant gaze or careful intense regard of the mother's face is an expression of the emotional bonding process (Tronick and Adamson, 1980). The infant's gaze signals interest and attention to the adult, who responds with a range of expressive facial and vocal behaviors. The important mutual reciprocal visual regard functions as the first mode of communication for normally sighted infants. As the infant learns that when he/she fixes his or her gaze on the adult, the adult responds by doing something with the infant; infant gaze becomes a social signal which initiates interaction. The experience of visual contact with the environment becomes linked to social behavior in sighted children (Tronick and Adamson, 1980; Trevarthen, 1980; Bates, 1979; Stern, 1977). The adaptive system of the infant is characterized by the ability to coordinate the focus of attention to that of the adult (Tronick and Adamson, 1980).

The development of reach and grasp also seems to depend on visual development. According to White et al. (1964) infants possess a visual-attentional behavior that allows them to look at and follow seen objects in addition to a touch-grasp behavior. The behaviors are initially separate and evolve, through experience, to the point when the infant becomes aware that the hand he/she looks at is also able to grasp objects. This results in an integration of visual-attention and grasping behaviors, allowing the child to coordinate his physical response and control his hand movements through his visual sense.

Important changes occur in the attentional abilities of infants during the first few months of life. Interesting light patterns command more visual attention than non-patterned stimuli. Fantz (1964) observed that young infants look longer at patterned than at plain surfaces, curved rather than straight lines, colored rather than neutral stimuli and novel rather than familiar stimuli. Werner and Siqueland (1978) found that infants with high perinatal risk scores (due to medical complications and longer periods of hospitalization) tended to respond less differentially to familiar and novel stimuli.

As the child becomes increasingly practiced in the use of his eyes and these optical skills become refined and established, then increasingly complex discriminatory functions continue to develop. The child is beginning to look in order to learn. These optical/perceptual functions are strongly tied in with exploratory play and manipulation of objects.

Visual attention is an expression of organized and integrated behavior. It is a perceptual and interpretive act that is far more than simply the fixation of the eye on a stimulus. Visual attention must be developed if the child is to make use of his or her vision as a pathway of learning.

Additional evidence that looking behaviors are acquired or learned in the course of interaction with the environment comes from the research conducted by Bower (1977). Bower noted that the environment seems to provide those experiences which refine the physiological act of seeing and link it to the conscious acts of exploring, understanding, and responding to the environmental stimuli. Early visual awareness seems to create a knowledge of the structure of the world that cannot be given by the other senses (Bower, 1977).

Development of Visual Attention in Multihandicapped Children

Our experience with visually impaired multihandicapped children has taught us that even the most severely handicapped child can learn to use the vision he/she possesses.

Developing visual attention in multihandicapped children requires a high level of interprofessional cooperation and expertise. Not only must the type of visual problem be clearly identified, but the possible interaction effects of severe visual impairment with other types of disabilities need to be clearly understood. This information is essential if we are to be able to create the kind of adaptive environment these children require. Van Dijk (1982) reported that stereotypic behavior such as shaking the hand in front of the face may itself be a consequence of the child's effort to obtain visual stimulation. Van Dijk noted that young Rubella children with growing cataract density tend to exhibit fascination with their fingers and lights. Other rhythmic habit patterns, such as body rocking and finger and toe sucking, may function to give the child control over motor actions. One important interpretation of these behaviors is that they are a result of the child's inability to respond appropriately to the demands of the environment (Van Dijk, 1982).

Other visual problems such as unequal vision, which Sonksen (1982) defines as vision that is virtually absent on one side and limited on the other, can lead to unbalanced levels of integration of auditory inputs from each ear, which is then manifest as an unequal ability to locate sound. Sonksen (1982) also noted that unequal levels of integration of vestibular afferents may lead to an inequality of postural reactions.

Whenever physical handicaps interfere with activity, every effort should be made to create physical adaptations so that the child can approximate the necessary movement as closely as possible. Enhancement of visual stimuli can be achieved by bringing them closer to the child's eye, using colors that are appealing and of good contrast, lighting it, and otherwise making it enjoyable to view. Because so many factors come into play with severe impairments, it is not possible to predict or expect any one type of consistent response or progression of skills. Given the opportunity to become aware that "looking is enjoyable," many children will develop an interest in "looking" (Barraga, 1964). The development of interest in visual stimuli triggers a general awareness and awakening of the mind in other areas.

Parents and teachers have numerous opportunities to observe these children in familiar surroundings on a continuing basis and can provide important information that will assist optometrists and ophthalmologists in making an evaluation. With guidance from an optometrist or an ophthalmologist concerning relevant behaviors that should be noted, a great deal of pertinent information can be gathered.

Multihandicapped children often relate best to objects that are part of their everyday experience. Functional materials such as food, clothing, or eating utensils may prove to be valuable tools in the observation of visual behavior of multihandicapped patients.

As professionals who are often called upon to make prognostic judgments, we need to exercise great caution. It is wise not to use the term "blindness" in connection with visually impaired infants or young multihandicapped children when the major clinical signs are a lack of fixation or tracking. The social implications of the term may mean that the child is treated as if he were totally blind and no effort made to stimulate him/her visually. This is the reason we are often surprised when the child begins to behave in a visual way. Since it is easier to instruct than to undo poor habits,

we need to give these children every possible chance for maximum learning. Expectation is an important part of this process and the diagnostic terms that are used are taken very seriously by parents.

We have a long way to go in understanding the dynamics of visual development. A research partnership between our professions can help to illuminate large areas of human development that still seem so elusive.

The Importance of Precise Oculo-Visual Assessment Information

Before any educational program can be developed, information of the precise nature of the child's visual condition and visual potential must be assessed. Such information answers the questions: What visual stimuli is the child able to receive? In what position can he or she best receive it? And what aids or adaptations can be used to assist? In order to determine the answers to these questions, optometrists and physicians need to be aware of the child's total condition.

Examination by conventional means is often unsuitable because of the many constraints placed on development by the multiplicity of impairments which interact with one another. The examination of multihandicapped children requires adjustments in the length of examination and materials used. Most of the tests commonly administered assess learned behavior and the multihandicapped child's repetoire of learned behaviors may not accurately reflect his/her potential to develop skills.

Conclusion

Conventional assessment procedures frequently rely on subjective responses involving expressive language and motor abilities. What is actually being observed during the examination is a patient's repertoire of learned behaviors. Children's command of expressive language and motor abilities determine the outcome of conventional assessment procedures. Because these are learned behaviors, it is the learned behaviors that are being observed and not the child's potential for learning. For example, successful performance with the Snellen chart requries that the child can attend to environment, has adequate motor control, language, and can recognize printed symbols as well as have sufficient vision to perceive the letters or symbols. A child may perceive the presented stimuli but not have the communication skill to indicate what has been perceived. The use of pictures or photographs which require an ability to relate to objects on a representational level may hinder an examiner's efforts to elicit responses from multiply-impaired children.

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