Cortical Visual Impairment (CVI)

Characteristics and Intervention Strategies

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INTRODUCTION

This is the second in a series of booklets on topics that are relevant to children and young adults who are deaf-blind. The content of each booklet is written to provide practical information to families and service providers. This year’s focus is on the topic of Cortical Visual Impairment (CVI) which has been identified as the leading cause of visual impairment in the western world (Jan, Good, & Hoyt, 2004).

CVI is a neurological condition that results from an insult to the brain or how a child’s brain was organized during its prenatal development. It affects how an individual processes and understands visual information. CVI can also be an acquired condition from an accident or a post-natal infection. The location and extent of a child’s brain damage determines which functional behaviors will be affected (Morse, 1999).

CVI can be found in children with and without ocular (eye) conditions. The degree of vision impairment depends upon the age of onset and the area and amount of damage to the brain. CVI can be a temporary or a permanent condition. A child with CVI may also have additional disabilities.

A few words about language…

CVI currently stands for multiple terms including cortical visual impairment, cerebral visual impairment, and cognitive visual impairment. “Cortical visual impairment” has been the term most often used to describe impairment of the visual function (e.g., visual acuity and visual fields) due to brain damage. But, according to Dutton (2005), “The problem with this term is that the cerebral cortex, from which this term is derived, is rarely damaged on its own” (p.27). Dutton uses the term “cerebral visual impairment” to describe how visual function involves both visual input and visual processing at several levels. This booklet will use the acronym “CVI” to describe the causes, behavioral characteristics, and interventions for this impairment.
CAUSES OF CVI

There are several known causes of CVI. The most common causes include:

- Anoxic brain damage – the brain receives no oxygen for several minutes or longer (e.g., asphyxia).
- Periventricular leukomalacia (PVL), an injury to the white matter of the brain that occurs primarily in premature infants.
- Hypoxic brain damage – the brain receives some, but not enough, oxygen (e.g., cardiac arrest, prolonged epileptic seizures, intraventricular hemorrhage).
- Infections of the central nervous system such as meningitis and encephalitis.
- Head injury (e.g., automobile accident, skull fractures from a fall).

It is important to be familiar with a child’s medical history in order to make an accurate diagnosis of CVI. The following list is an example of the kinds of questions that may give families and service providers additional insight into a child’s vision condition.

- Did the mother have a normal pregnancy?
- Was there any trauma during or after birth?
- Has there been an occasion when the child stopped breathing?
- Does the child have hydrocephalus or microcephaly?
- Has there been an accident or insult to the child’s head?
- Has the child contracted any infection that might affect the child’s central nervous system?

“CVI gets better or it gets worse but it does not remain the same because the brain does not remain the same.” Roman, 2005
Assessing Children with CVI

There are various formal and informal methods of diagnosing CVI. An accurate diagnosis will consist of both methods “within the context of a transdisciplinary assessment” (Langley, 2005). This kind of team approach uses a combination of professionals (e.g., ophthalmologist, teachers, physical/occupational therapists, neurologist) and family members to make a diagnosis and conduct a comprehensive assessment.

Formal assessment components may include:

- Pediatric eye exam – conducted by an ophthalmologist. A child may have “normal” looking eyes but children with CVI can also have abnormal eye conditions.
- A Visual Evoked Potential Map (VEP) – a computerized method of detecting electrical activity, or lack thereof, in the visual cortex when the child is exposed to visual information.
- PET – Positron Emission Tomography – a powerful imaging technique that accurately scans the cellular functions of the body
- A CAT Scan – uses special X-ray equipment to obtain image data from different angles around the body. It can detect evidence of bilateral lesions of the visual cortex

Informal assessment components should include:

- A functional vision evaluation to determine how much vision a child has for use in communication, orientation and movement, daily activities, and sustained near vision tasks
- A detailed medical history to determine any neurological problems
- Observation across multiple settings during different activities at various times of the day under different lighting conditions
 Interviews with family members/teachers to get information about how a child functions in daily routines and interactions

Using both formal and informal methods of assessment can assure that a child is accurately diagnosed and environmental/instructional strategies are developed to meet the needs of the child.

“When a child with CVI needs to control his head, use his vision, and perform fine motor tasks, the effort can be compared to a neurologically intact adult learning to knit while walking a tightrope.”

(Jeri Hart, Vision Impairment Specialist, Blind Babies Foundation)
Key Characteristics of CVI

There are several common characteristics that are demonstrated by children with CVI. Even though these characteristics have been noted in a variety of children it is important to remember that each child is unique and may or may not display all of these behaviors.

1. Children with CVI have fluctuating vision that changes from day to day. Their vision changes because the environment changes all the time. Changes can also occur because of other factors like fatigue, noise level, illness, medication, seizure activity, and unfamiliar people, places, and activities.

2. Children with CVI typically rely on their peripheral vision rather than their central vision. Peripheral vision is a part of vision that occurs outside the central line of gaze. The peripheral system is laid deep in the brain so it is more difficult to damage. A child may also have a preference for peripheral vision on one side and a preference for central vision on the other side.

3. Children with CVI are often unable to look at and touch a visual target at the same time. They may look at the target, touch it, and look away, then slowly return to looking at what they are touching.

4. Children with CVI have difficulty viewing items against a cluttered/crowded background (e.g., bulletin boards, walls, patterned clothes). They may have difficulty finding an object within an array of objects. Children with CVI can also have difficulty looking at the human face which is very complex. Out of the face comes sound. A child may choose to listen but not look at another person.

5. Children with CVI respond to movement cues, especially in their peripheral field. Sometimes a child will move themselves if there is nothing to look at that moves. The brain seeks visual input. It may not be functional movement but it keeps vision activated.
6. Children with CVI have difficulty with visual novelty and prefer interacting with familiar objects. Even though our brains are wired to look at novel things children with CVI seem to gravitate towards items they have seen over and over again versus a new item.

7. Children with CVI have a need to touch or mouth objects to get information.

8. Children with CVI may have a delayed visual response time. This behavior can add to inconsistent responses and be misinterpreted as inattention or noncompliance.

9. Children with CVI appear to have intact color vision. Color vision is laid bilaterally and deep in the brain. Red and yellow tend to be the main colors of interest. These colors have the slowest and the longest cycle or waves. (Roman, 2005).

10. Children with CVI often have difficulty with depth perception and spatial vision. This issue affects their ability to reach for visual targets and has an impact on gross motor movements.

11. Children with CVI do not have the ability to suppress excess information and may “shut down” when over-stimulated, especially visually. They may also turn away to remove themselves from input or get agitated because they are bombarded by incoming sensory information.

12. Children with CVI tire easily. It takes a lot of energy for a child with CVI to use his vision. Time must be spent filtering out targets in complex backgrounds, trying to manage verbal input, and discriminate different visual images.

13. Children with CVI are often attracted to lights which may satisfy a need for input. They may turn to the light and stare or wave their fingers in front of it. At the same time, children with CVI can be sensitive to bright or outside light.

“Visual attention does not automatically mean cognitive understanding.” (Morse, 1999)
Strategies for Building Visual Skills in Children with CVI

There are various educational and environmental strategies that can be used to assist a child with CVI to improve and use his vision. People who interact with a child need to become good observers of the child’s behavior and visual responses. They need to pay attention to when and where the child seems to use his vision and under what conditions. They also need to think about how things have changed in a particular environment including an increase in sensory input. The following strategies can help families and service providers design programs and instruction that provide the most optimal conditions for a child “to see” and use his vision.

❖ Keep it Simple

The world is a visually complex place for a child with CVI and therefore families and teachers should remember the old adage to “keep it simple.” Because a child with CVI has difficulty controlling the visual input in the environment, it is important to reduce as much extraneous sensory input as possible. For example, a teacher will want to present information against a simple background and use objects that are one color (e.g., red ball) versus a multiple colored item. It may also be important to present a single object versus an array of objects on a background that will create some contrast (e.g., red car on a black piece of poster paper).

❖ Position, Position, Position!

Make sure that the child is in an optimal position to use his vision. This is a critical condition. A child should be comfortable and able to focus his energy on the visual task. If a child has to concentrate on holding his head up, looking at an object or a person, and following verbal directions at the same time he may become overloaded, unresponsive or agitated.
Where’s That Field of Vision?
Find the child’s “field of vision” (where the child sees). Which way does the child’s head turn and/or eyes look? The “field of vision” will be different for each child and the response to educational and environmental input will also be unique to each child. An informal assessment of how a child uses his vision and under what conditions will be very helpful in designing strategies and environmental adaptations.

What’s Your Favorite Color?
Identify the child’s color preference. Do some informal assessment and see if you can identify the child’s favorite color. Children with CVI are often times attracted to fluorescent and glittery items (e.g., gold glittery pom-pom). Color can be a strength for a child with CVI and create a path to a variety of instructional opportunities. It can be used to encourage visual attention to functional objects, toys, and people. For example, a solid red cup or comb may be presented in a child’s peripheral visual field, the child can then touch the object before it is used. Additionally glittery material like strips of Mylar paper can be attached to an item to attract a child’s attention before using an object. Color can be used to create an organizational strategy to code items in a communication system or to identify certain places in a school or home.

A Few of my Favorite Things
Use familiar objects/toys. Having concrete examples of familiar objects or representational cues of a motivating activity can help a child recognize an activity. Using familiar objects can also increase a child’s visual attention (Anthony, 2004). Known people, places, and things reduce a child’s stress level in that he can learn to rely on and understand the activities of the day. Familiar objects also create an opportunity to develop a child’s receptive and expressive communication system and help him make choices throughout the day. For example, Mrs. Jones has
developed an object/texture calendar system for Claire. The objects/textures represent the activities of Claire’s school day. The objects include a small gold glittery pom-pom that represents circle time, a red cup to represent snack time, a red comb for the restroom, a small piece of linked chain with some red glittery material to represent recess, and a piece of the strap from Claire’s backpack again, with red glittery material attached to it, to represent “home.” The items are presented to Claire before each activity. The teacher presents the items in Claire’s visual field – right peripheral side- and then has her touch the objects/textures before each activity begins. This is a way to give Claire information both visually and tactically. Mrs. Jones presents these cues one at a time and then briefly tells Claire what activity is going to happen – “Time to go home.” She is careful about presenting too much input at the same time and always gives Mary an opportunity to focus on and process each cue.

One Sense at a Time

Limit the child’s sensory input. Children with CVI can oftentimes only process one sensory modality at a time. If a child is looking at a person or an object he may not be able to listen to directions and touch the object at the same time. Too much sensory input can be stressful and a child may simply “shut down” as a way to get away from the input. Service providers and family members may want to initially require a child to focus his energy on one sense and slowly add other senses (e.g., vision, touch, hearing) when the child is more familiar with the activity/routine. Children with CVI also have preferred senses that can vary with different tasks and in different environments. For example, a child may choose to use touch instead of vision in a particular environment because it provides more information and is not as overwhelming (Greeley, 1997). Teachers and family members should pay attention to the kinds of activities and input a child is exposed to and the kinds of environmental conditions (e.g., noise, light, clutter) that make a child shut down or become agitated.
Think Before you Speak

Understand when and how to give a child verbal information or instruction. It is important to develop a child’s receptive communication system by describing an activity or environment but too much verbal input can also be overwhelming for a child with CVI. Many teachers and families think that they are not “teaching” a child unless they are talking to him. Even though developing a child’s language/communication system is critical, it is also important to keep in mind that a child with CVI may have difficulty managing all the sensory input in his environment. Teachers and families should think about not always giving information verbally but rather “talking” with movement and touch. For example, Noah is overwhelmed by too much auditory and visual input. His teacher, Nancy, knows he likes to play with and can use his vision to see his favorite red Elmo toy. Nancy sits on the floor close to Noah and makes sure that Elmo is within his visual field. She wants him to visually locate the toy and then try to get it. She does not direct him with her voice but rather moves Elmo, waits until he sees it and when he starts towards her she moves away. Noah loves this game and not only is required to use his vision in a meaningful way but also has to make some decisions about when and where to move.

Remember that Pause

Stop! Wait for the child’s response. Because children with CVI can be overwhelmed by too much sensory input they need time to process and organize incoming information. Service providers and family members need to monitor themselves and remember to “pause” before they expect a response from a child with CVI. The time a child takes to process information and make a response will vary from child to child. The factors that influence a child’s response time will depend on how familiar the child is with the activity, the environmental conditions (e.g., light, noise) under which the child is being asked to respond, and what kind of response the child is being asked to give to an adult or peer.
Movement Makes a Difference

Use movement cues to stimulate the child’s visual attention. Children with CVI have an interest in objects that move in space. Because movement is such an important factor, a child may even move himself to see an object if there is nothing to look at that moves (Roman, 2005).

Movement can be a useful strategy in improving a child’s vision but it can also be a distracter. Parents and teachers should carefully analyze the environment and make sure that there are not other moving things around the child which can add to the complexity of the environment.

Getting in Touch

Recognize how important touch is for a child CVI. Because touch is a critical way of gathering information for a child with CVI, the adults and peers in a child’s life should always provide tactile information about what is happening in the environment. These kinds of strategies might include having peers and adults use tactile cues (e.g., ring, bracelet, watch, a peer’s ponytail) as well as verbal information to introduce themselves, developing an object/texture schedule system, and/or presenting textures within the context of an activity to give a child information.

“About 80% of the brain, working as functional systems, is required to efficiently process and understand a visual message.” (Morse, 1999)

CVI is a complex condition. We are all constantly receiving sensory input from our environment but most of us are able to manage, organize, and process that input. Children with CVI will vary in their ability to tolerate such input as far as the amount
and intensity. Service providers and families should always try and understand any experience and environment from a child’s perspective. Finally, it is important to remember that it is the quality of the visual input and not simply being exposed to the visual world that is important for a child with CVI.

### Some Characteristic Differences Between Pure Ocular & CVI

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Ocular Disorder</th>
<th>CVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye examination</td>
<td>Usually abnormal</td>
<td>Normal</td>
</tr>
<tr>
<td>Visual function</td>
<td>Consistent</td>
<td>Highly variable</td>
</tr>
<tr>
<td>Visual attention span</td>
<td>Usually normal</td>
<td>Noticeably short</td>
</tr>
<tr>
<td>Sensory nystagmus</td>
<td>Present when congenital &amp; early onset</td>
<td>Not present</td>
</tr>
<tr>
<td>Poorly coordinated eye movements</td>
<td>Present when congenital &amp; early onset</td>
<td>Usually normal</td>
</tr>
<tr>
<td>Rapid horizontal head shaking</td>
<td>Occasionally</td>
<td>Never</td>
</tr>
<tr>
<td>Compulsive light gazing</td>
<td>Rarely</td>
<td>Common</td>
</tr>
<tr>
<td>Light sensitivity</td>
<td>Depends on eye disorder</td>
<td>In 1/3 of cases</td>
</tr>
<tr>
<td>Eye pressing</td>
<td>Especially in congenital retinal disorders</td>
<td>Never</td>
</tr>
<tr>
<td>Close viewing</td>
<td>Common for magnification</td>
<td>Common for magnification, a reduction in clutter / crowding or both</td>
</tr>
<tr>
<td>Color perception</td>
<td>Depends on eye disorder</td>
<td>Preserved</td>
</tr>
<tr>
<td>Appearance</td>
<td>Appears visually impaired</td>
<td>Usually normal</td>
</tr>
<tr>
<td>Peripheral field loss</td>
<td>Occasionally</td>
<td>Nearly always</td>
</tr>
<tr>
<td>Presence of additional neurological issues</td>
<td>Fairly common</td>
<td>Nearly always</td>
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