Vision Habilitation

Teaching Children How to See

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Habilitation

Definition

- Habilitation refers to a process aimed at helping disabled people attain, keep or improve skills and functioning for daily living.
- For pediatric patients, *habilitative therapy* helps a child develop skills that they have yet to accomplish.
- Rehabilitation refers to regaining skills, abilities, or knowledge that may have been lost or compromised as a result of illness, injury, or acquiring a disability.

Habilitative therapy is often required by law to be covered by insurance.

1. What does it mean to teach a child how to see?
2. When do you start?
3. How does it work?
4. How do you start?
5. What are the measures of success?
6. What tools work best?

Components of Vision

(In no particular order)

- Color
- Luminance
- Contrast
- Movement
- Size
- Shape (points, lines, curves)
- Position
- Eye movements
- Binocular vision (stereopsis)
- Peripheral vision
- Pattern recognition
- Figure-ground
- Focusing
- Image orientation
- Data integration
- Context and meaning

Steps in the process of sight (non-optometric)

1. Light enters the eye
2. Pupil adjusts to the light
3. Reflex focusing
4. Signal conversion
5. Brain processing
6. Perception and interpretation

(Where is ocular motor control?)

General theory of how infants learn to see

NIH and others

- Initial Chaos (Before Experience): Before eyes open, neurons fire somewhat randomly, creating unstable patterns with no clear meaning.
- The Role of Motion: After birth, motion is crucial; it helps teach the brain which visual elements belong together (e.g., "things that move together are one object").
- Neural Alignment & Stability: With repeated exposure, neurons in different brain modules start firing in sync and responding to the same features, creating stable, reliable patterns for specific visual inputs (like a face or object).
- Building Representations: This alignment allows the brain to parse complex images, distinguishing shadows, colors, and shapes to form complete objects, moving from fragmented perception to coherent understanding.
- Experience Shapes Circuits: Early visual input sculpts the visual cortex, making it efficient at interpreting the world, but the brain remains capable of learning significant visual function even after years of deprivation, demonstrating plasticity.

Module theory of vision

https://neurosciencenews.com/open-eye-visual-learning-29677/

- **Early Mismatch:** Before eye opening, neurons send inconsistent signals to visual modules.
- **Experience Matters:** After visual input, neurons and modules align, stabilizing visual responses.
- **Learning Boost:** Pre-wired modular activity primes the brain for rapid, efficient learning.
- The scientists also found evidence predicted by their model that, before experience, interconnected modules receive information that represents different features, in contrast with the experienced circuit, where highly interconnected modules respond to similar features.
- This means that for learning to occur, "the visual information received by the modules must increase in reliability"; and "the information coming into the modules must become better aligned with the connections between those modules."

- The brain learns to see through a dynamic process where early visual experiences, **especially motion**, train neural circuits to align and form stable object representations, shifting from chaotic signals to organized patterns that allow for perception of edges, colors, and whole objects over time, even for those gaining sight later in life.

Looking at the second interpretation of how the brain learns to see, ocular motor control is critical. Non-optometric research seems to ignore this, and presumes that ocular motor control develops normally, independent of ocular and brain disorders. This is erroneous with patients requiring habilitative therapy and often with patients requiring rehabilitative intervention.

Cortical Visual Impairment vs. Cerebral Visual Impairment

- Differentiation between CVI and agnosia
- CVI presumes brain damage, whether documented or not, based on probable history
- Cerebral and cortical visual impairments are not considered the same thing. "According to Dutton and Lueck (2015), "Cerebral visual impairment ... refers to disordered vision or visual perception of any type or severity as a result of damage or disorder to the visual pathways or centers of the brain" (p. 9). In contrast, cortical visual impairment is a type of brain-based visual problem to which specific criteria can be applied. "
- NVI (neurological visual impairment) is more inclusive

Cortical Visual Impairment
Roman-Lantzy, Christine;

"However, despite the difficulties in recognizing CVI, it is nonetheless identified as the primary cause of visual impairment in children in so-called first-world countries where advanced medical interventions are available to infants and children (Flanagan, Jackson, & Hill, 2003; Skoczenski & Good, 2004), and it is likely to remain so for the foreseeable future because of increased survival rates among critically ill infants and children."

" Eagleman (2015) states that "the eye develops through biology but the visual cortex develops through experience."

Cortical Visual Impairment

Roman-Lantzy, Christine;

"There is an important relationship between advances in medicine and the numbers of neurologically affected surviving individuals, a relationship resulting in greater numbers of infants and children with CVI."

"Cortical visual impairment (CVI) is now the most common cause of visual impairment in children in developed countries (Flanagan, Jackson, & Hill, 2003),"

Cortical Visual Impairment

Roman-Lantzy, Christine;

"The TORCH infections (toxoplasmosis, rubella, cytomegalic inclusion disease, and herpes simplex) are a collection of infections that can be passed from mother to fetus in utero."

These can all cause congenital cataracts.

"According to the American Association for Pediatric Ophthalmology and Strabismus (AAPOS, 2015), metabolic disorders are a significant cause of CVI."

Cortical Visual Impairment

Roman-Lantzy, Christine;

"CVI has been estimated to occur in 21 percent of individuals with genetic diagnoses (Bosch, Boonstra, Willemsen, Cremers, & de Vries, 2014). Genetic causes of CVI can also be associated with coexisting ocular considerations such as coloboma, refractive disorder, or nystagmus (Brodsky et al., 2002). Parents and providers should be alert to the possibility of CVI in children who have been labeled with one of the "alphabet soup" type of codes used to describe a genetic difference. Diagnoses such as 13+p (addition of genetic information on the p arm of the 13th chromosome) or 11–q (deletion of genetic information on the q arm of the 11th chromosome) are examples of atypical chromosome findings."

Cortical Visual Impairment

Roman-Lantzy, Christine;

CVI Related Characteristics and Disorders

Color preference: The individual is attracted to color, sometimes a particular color.

Need for movement: To initiate or sustain visual attention: Either the viewer or the object viewed needs to be moving to maximize the viewer's ability to view the object.

Visual latency: Responses in looking at objects are delayed.

Visual field preferences: There are areas within the peripheral fields where targets are able to be seen and areas where targets are not able to be seen. Lower visual field dysfunction is common.

Difficulties with visual complexity: Categories of difficulty include complexity of the surface of the target viewed, complexity of the array of objects to be viewed, complexity of the sensory environment within which viewing takes place, and complexity of the human face.

Need for light: The individual is attracted to primary sources of light and needs light to be paired with a target to view the target.

Difficulty with distance viewing: The individual cannot isolate targets beyond a certain distance.

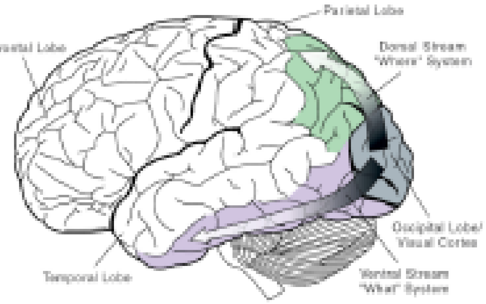
Atypical visual reflexes: The reflex to blink in response to an approaching object is absent or impaired.

Difficulty with visual novelty: Increased visual attention is paid to targets that are familiar; there is a lack of visual curiosity.

Absence of visually guided reach: The ability to look at and touch an object at the" same time is not displayed; these two actions are typically performed separately."

FIGURE **1.3 Dorsal and Ventral Streams**

(Description)



Two systems of visual processing, the dorsal and ventral streams or pathways, originate from the visual cortex and serve different functions in the brain.

Source: Adapted from Selket, made from File:Gray728.svg, CC BY-SA 3.0. Retrieved from https://commons.wikimedia.org/w/index.php?curid=1679336

CVI Characteristic	Dorsal Stream ("Where" System)	Ventral Stream ("What" System
Color preference	X	X
Need for movement	X	
Visual latency*		
Visual field preferences	X	
Difficulties with visual complexity		X
Need for light	X	
Difficulty with distance viewing		X
Atypical visual reflexes*		
Difficulty with visual novelty		X
Absence of visually guided reach	X	X

Credit: Christine Roman-Lantzy

Caption: Some students with CVI who have difficulty with distance viewing behave as though they were highly nearsighted, getting close to the target to eliminate visual clutter.

- Most children with CVI are attracted to targets with movement. Sometimes they can only "see" the target if it or they are moving.
- These children may show a significant delay in responding to what they see, and may act as if there is no target present.
- **Children with CVI may behave as if they are highly nearsighted. They may put their face very close to the object of regard. They may have difficulty recognizing even large or familiar objects beyond a certain distance, irrespective of ophthalmic refractive status. Bringing objects closer eliminates background and simplifies the complexity of the array.** This is associated with the ventral pathway.

Is this how high myopia is induced in impaired children?

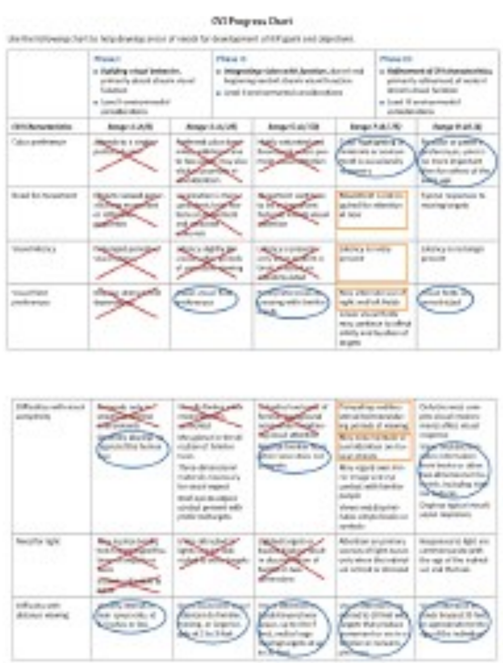
Visual Fields

"Based on evidence obtained in 2015 from 431 individuals with CVI who received evaluations at the Pediatric VIEW Program (Roman-Lantzy & Lantzy, 2002–2017), dysfunction of the lower visual field was the most common visual field disorder found. Lower visual field difficulties may be evident in certain behaviors that include tripping on drop-offs and steps, stumbling over obstacles on the floor, and being unable to locate objects that are close to the body between the chin and waist. Orientation and mobility instruction is a necessary intervention for individuals who have visual field difficulties."

Recommended Diagnostic Assessment

Functional Vision Component Assessed	Type of Visual Impairment		
	Ocular Visual Impairment	*Cortical Visual Impairment*	*Ocular and Cortical Visual Impairment*
Visual acuity	Near and distance abilities assessed for acuity	Not correlated with the visual functioning of individuals with CVI Not appropriate for educationally based assessment	Assessed depending on the suspected or diagnosed ocular condition
Visual fields	Assessed	Assessed; generally a modified confrontation technique	Assessed
Visual motility (eye movements)	Assessed	Not assessed	Assessed depending on the suspected or diagnosed ocular condition
Visual binocularity	Binocularity function is noted but is formally evaluated by an eye care specialist	Many individuals with CVI have strabismus, formally evaluated by an eye care specialist	Many individuals with CVI have strabismus, formally evaluated by an eye care specialist
Lighting	Assessed: type, position, and intensity of lighting preferred	Assessed: the degree to which light supports or distracts visual attention	Assessed for both ocular and CVI considerations
Contrast sensitivity	Assessed	Not assessed	Assessed depending on the suspected or diagnosed ocular condition
Color	Assessed: ability to perceive color and to discriminate hues of color	Assessed: the degree to which color is necessary to establish or sustain visual attention	Assessed for CVI considerations, but may include color perception and discrimination, depending on the suspected or diagnosed ocular condition
Need for movement	Not assessed	Assessed: the degree to which movement is necessary to establish and maintain visual attention, or as a potential source of distraction	Awareness is necessary that some ocular conditions result in decreased peripheral vision; therefore, perception of movement may be affected
Visual latency	Not assessed	Assessed: the presence and degree of delayed response	Assessed for CVI considerations
Impact of visual complexity	Not assessed	Assessed: complexity of the surface of a target, complexity of the visual array, complexity of the sensory environment, and complexity of human faces	Assessed for CVI considerations Awareness is necessary that some ocular conditions result in affected central vision or reduced acuity, confounding the CVI issue of difficulties with visual complexity
Distance viewing	Assessed as part of visual acuity evaluations	Assessed; closely associated with complexity and familiarity of the environment	Assessed for CVI and ocular considerations
Visual reflexes associated with CVI	Not assessed	Reflex differences assessed The visual blink reflex and visual threat response are evaluated	Assessed for CVI considerations
Impact of visual novelty	Not assessed	Assessed: the degree to which novel visual inputs affect visual attention and interpretation	Assessed for CVI considerations
Visual motor skills (absence of visually guided reach)	May be evaluated as eye-hand coordination or difficulties with depth perception associated with some ocular conditions	Assessed: the degree to which the individual looks, looks away, and then attempts to reach with the hand	Assessed for CVI considerations May be assessed for ocular considerations, depending on the suspected or diagnosed ocular condition

Progression chart



What We Know Now:

- The higher the CVI Range score for a child, the more CVI-related intervention and support necessary. There is almost an inverse relationship between the score on the CVI Range and the requirements for adaptations and specialized instruction.
- Interventions need to be carefully designed to match the level of CVI the child is experiencing and address the findings reflected in the CVI Range score. Random approaches have random results.
- Intervention must be driven by intention, not by materials. It is not enough to have lighted objects, or shiny red beads. The materials need to be designed to support instruction, not to lead it.
- Intervention really means the implementation of an approach in which the activities and routines of the day are adapted to provide the child with visual access.
- Regardless of the cause of an individual's CVI, with appropriate intervention, there is a progression of improvement that begins in Phase I and moves systematically into Phases II and III.

Optometric Interventions

Balloon search

- Use multiple mylar balloons with weights positioned around the room.
- The child must find and touch each balloon.
- Note the search pattern.
- Note any field neglect.
- Note any repetitions.
- Note color preferences.
- Upgrade by putting large numbers on each balloon. Can the child find the numbers in order?

Floor maze

- Use bright colored duct tape to make a maze on the floor. Start with simple tracks and make it more complex as the child is able to follow.
- This stimulates the inferior field, awareness of where the feet are, as well as tracking.
- As the child's ability improves, switch to regular reflective duct tape with less color.

Using lights

- Set up appropriate targets at mid-range (1 M).
- Use a tactical flashlight (condensing beam) and have the child name each target as it is highlighted.
- Can the child aim a light at each target as told to do so? This requires identification, spatial localization, and visually guided motor responses.
- With an older child a laser can be used for more precise targeting.
- Smaller targets and a larger display can be used, introducing figure-ground as well as identification.

Tracking lights through a simple maze

After the child can see and identify the colors, we can make the task more complex and require attention to multiple objects.

Can they coordinate their hands with the movement of the balls?

Can they follow multiple targets simultaneously?

Can they accurately report what they see?

Can they move the balls rhythmically?

Although no longer as popular, use flashing rings, finger lights, or flashing gloves to help the child see where their hands are.

(These were purchased on Aliexpress, and have variable flashing speed.)

https://he.aliexpress.com/item/1005007902627782.html?spm=a2g0o.order_detail.order_detail_item.13.6760f19cRDcnP2&gatewayAdapt=glo2isr

A child needs to know where their hands are.
This is done by getting afferent feedback from motor systems, and progressing to matched visual stimulation.
This also stimulates bilaterality, which is necessary as a precursor to binocularity and can stimulate the development of the corpus callosum.

Children also need to know where their feet are.
Move both feet together, then alternate.
Use flashing rings on their feet to maintain visual attention.
Add cognitive aspects by counting, or using music and teaching the child to follow the rhythm.

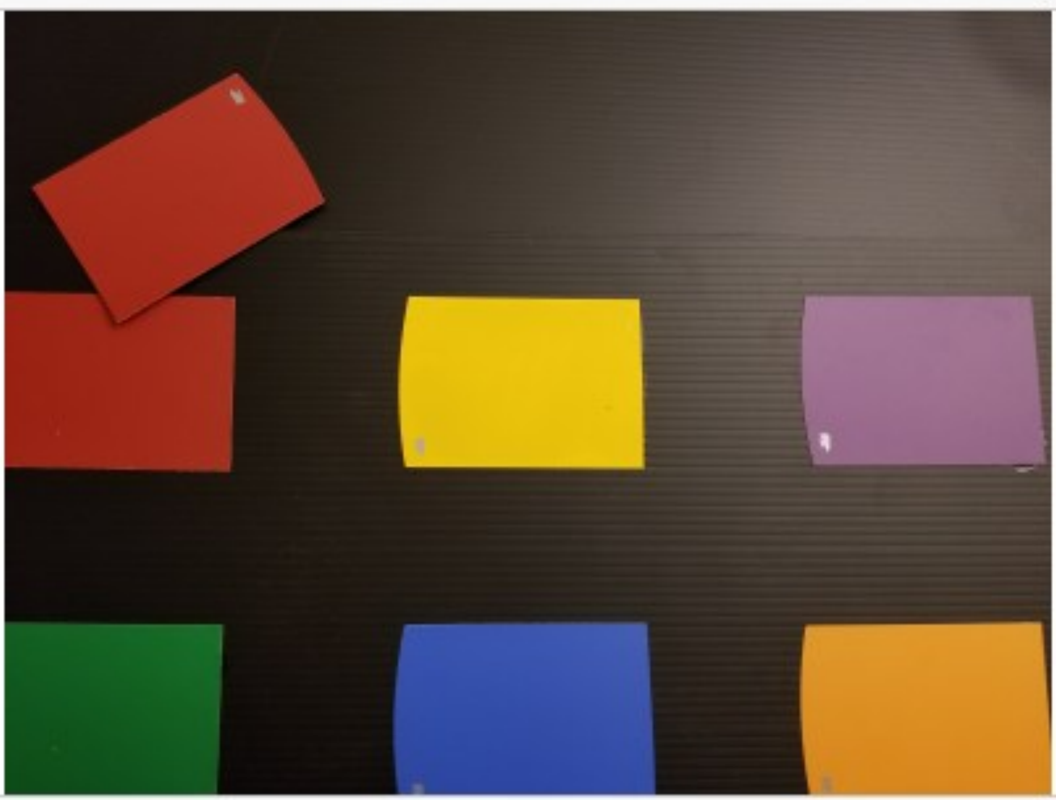
Activities for vision habilitation

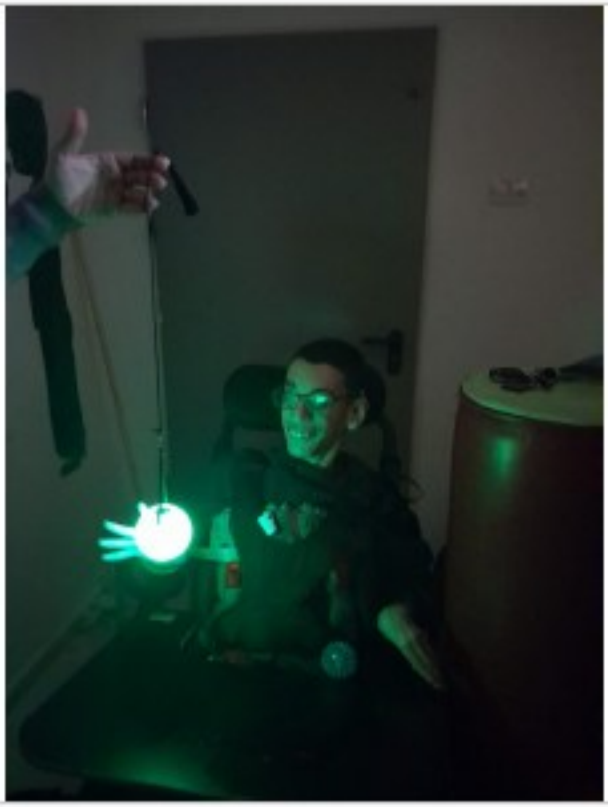
Color awareness - start with recognizing red.

Work up to color matching with a choice of two, increasing the matching display.

As the child is able to discriminate more colors, work on labeling them.

Increase the color matching chart with similar hues and variable saturation.





- For children who are very low functioning, use light-up balls to stimulate awareness of position and movement.
- Encourage motor responses; patting the ball, grasp and release, passing from one hand to the other.
- These can be swinging balls or lights inside plastic spheres.
- The small lights inserted in the spheres can be purchased in separate colors.
- Using different colored lights also stimulates focusing.

The lights are slightly larger than 1 cm.

The plastic balls are 2.5 cm across.

Keep the tab to reinsert and reuse the light.

Squeeze the ball to open it.

1. They can be placed around the room.
2. Putting them on a busy background stimulates figure-ground awareness.
3. The lit balls can be put into a box of other objects to be found and sorted.

A head mounted laser stimulates visual attention.

It also trains awareness of movement, position, and synchronizes head and eye movements.

It can be used to stimulate visual fields and improve oculomotor control.

Adding a background stimulates figure-ground Awareness. Start with a checkerboard. Use stripes With various orientation.

Recommended reading

- https://afb.org/blindness-and-low-vision/eye-conditions/cortical-visual-impairment-traumatic-brain-injury-and
- https://dokumen.pub/qdownload/cortical-visual-impairment-an-approach-to-assessment-and-intervention-2nd-edition-2nbsped-9780891287964-9780891286882.html