There is Emerging Evidence that Fixation Training, When Incorporated in a Visual Stimulation Program, may be Effective for Children Birth to 10 years Old with Cortical Visual Impairment

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CLINICAL SCENARIO:

Client population:

Pediatric population ranging from birth to 10 years of age.

Treatment context:

Home, Outpatient, Day care

Problem/condition this intervention is used for:

Cortical Visual Impairment (CVI) is a visual impairment that occurs due to damage within the posterior visual pathway. This pathway extends from lateral geniculate nucleus to the visual cortex within the brain. A CVI can occur because of perinatal and postnatal brain damage. All the structures of the anterior visual pathway, which includes structures of the eye, optic nerve, optic chiasm, and optic tract, remain intact. The child is able to see what is within their environment, but are unable to process the visual input. The child will be unresponsive to visual stimuli and will have troubles sustaining attention on objects within their environment (Roman-Lantzy, 2007). CVI have strong comorbidities with other cognitive or neurological deficits for example hypertonia, hemiparesis, microcephaly, and seizures (Tsai, Meng, Wu, Jang, and Su, 2013). Health professionals may overlook CVI because problems observed may be contributed to cognitive problems experienced from brain damage.

Intervention:

Fixation training is an intervention used to help a child fixate on an object for a sustained period of time utilizing any of the following techniques: attend to the child's preference of color or objects and light. The therapist utilizes the child's preferences to motivate the child to not only see, but visually attend to the object. When the child fixates on the object it is thought that the child will establish a focal point, which will facilitate clear vision, promote exploration of the environment, refine performance in ADLs and improve overall quality of life. Having the child fixate on an object during play or an ADL task will help to re-establish lost connections within the brain and increase visual attention of the child.

Science behind intervention:

A child with a CVI has lost the communication in the posterior visual pathway. This pathway is responsible for the communication between what is perceived by the eye and how that visual information is processed by the visual cortex within the brain. Fixation training utilizes the concepts of neuroplasticity. Encouraging the child to continually look at a stimulus will help to re-establish the lost connections of the posterior visual pathway.

Why is this intervention appropriate for occupational therapy?

Fixation training will allow the child to perceive stimuli within their environment and this will help with exploration and development. This intervention targets the body functions of attention and visual functioning. It also addresses the performance skill, attends.

What ICF level is the intervention?

The ICF level for this intervention is body structure/body function.

Key Terms:

-Functional/residual vision: Person's current visual skills and abilities to perform daily tasks, and how the individual applies his/her vision in real life activities or environments. Specific examples include fixation, visual tracking, light orientation, motion perception, and luminance discrimination.

Assessments of functional vision include standardized and non-standardized tests during play to assess visual functions and observe the child's use of vision with everyday situations.

-Visual stimulation program: overall intervention used when treating CVI including fixation training as well as using high and low contrast within the environment, environmental modifications, tactile cues, and light reflex.

FOCUSED CLINICAL QUESTION: Is fixation training effective compared to no treatment to improve residual vision and optimize visual responses in children from birth to 10 years old with cortical visual impairments?

SUMMARY:

This paper looks at if fixation training is an effective intervention compared to no treatment to improve residual vision and optimize visual responses in children from birth to 10 years old with cortical visual impairments. A comprehensive search of the UW System databases and Google Scholar was completed and three relevant articles were found. All three of these articles were used as they were the only articles found and fit the necessary criteria. One of the articles was a case report level 5, another article was a quasi-experimental level 3b, and the third article was a cohort level 4. This results in a grade D evidence to support the effectiveness of fixation training to improve residual vision in children birth to 10 years old with CVI/ brain damage. These articles support the emerging evidence that fixation training is effective in increasing residual/functional vision in children birth to 10 years old with cortical visual impairment when incorporated in a visual stimulation program.

CLINICAL BOTTOM LINE: The effectiveness of fixation training in children age birth to 10 years old cannot be determined when utilized as the primary means of intervention; however fixation training in conjunction with other means of visual stimulation programs showed improvements in residual/functional vision based on the three articles despite differences in outcome measures, intervention time, intervention protocol, variable measured, and treatment schedules.

One of the articles was a case report level 5, another article was a quasi-experimental level 3b, and the third article was a cohort level 4. This results in a grade D evidence to support the effectiveness of fixation training to improve residual vision in children birth to 10 years old with CVI/ brain damage.

Limitation of this CAT: This critically appraised paper (or topic) has been reviewed by occupational therapy graduate students and the course instructor.

SEARCH STRATEGY:

Table 1: Search Strategy

Databases Searched	Search Terms	Limits used	Inclusion and Exclusion Criteria
A comprehensive search of the UW System Data Bases and Google Scholar were used for all the following search terms	CVI	Pediatrics Children Infants Occupational Therapy No limits	Peer reviewed No Criteria Used
	Cortical Visual Impairment	Pediatrics Children Infants Occupational Therapy Prior to 2004 No limits	Peer reviewed English Only Full Text No Criteria Used
	Cortical Visual Impairment + pediatrics	Prior to 2004	English Only Full Text
	Cortical Visual Impairment + Children	Prior to 2004 No limits	English Only Full Text No Criteria Used
	Cortical Blindness	Pediatrics Children Infants Occupational Therapy No limits	Peer reviewed No Criteria Used
	CVI range scale	Pediatrics Children Infants Occupational Therapy No limits	Peer reviewed No Criteria Used
	Fixation Training	Pediatrics Children Infants Occupational Therapy Prior to 2004 No limits	Peer reviewed English Only Full Text No Criteria Used
	Fixation + Pediatrics	Prior to 2004	English Only Full Text
	Fixation + Children	Prior to 2004	English Only Full Text
	Fixation + eye + Cortical Visual Impairment	Prior to 2004	English Only Full Text
	Children with CVI	No limits	No Criteria Used
	CVI Treatment	No limits	No Criteria Used

	Cortical Visual Impairment Treatment	No limits Prior to 2004	No Criteria Used English Only Full Text
	CVI Rehabilitation	No limits	No Criteria Used
	Fixation Training and Cortical Visual Impairment	Prior to 2004	English Only Full Text
	Fixation Training and CVI	No limits	No Criteria Used
	Cerebral Visual Impairment	No limits	No Criteria Used
	Color Preference and CVI	No limits	No Criteria Used
	Chromatic Fixation Training	Prior to 2004 No limits	English Only Full Text No Criteria Use
	Chromatic Fixation Training + Pediatrics	Prior to 2004	English Only Full Text
	Chromatic Fixation Training + Children	Prior to 2004	English Only Full Text
	Visual Stimulation and CVI	No limits	No Criteria Used
	Visual Stimulation and Cortical Visual Impairment	No limits	No Criteria Used
	Vision Disorders + Fixation Training	Prior to 2004	English Only Full Text
	Vision Disorders + Fixation Training + Children	Prior to 2004	English Only Full Text
	Vision + Training Cerebral damage + eye damage	Prior to 2004	English Only Full Text
	Cerebral Damage + eye damage + children	Prior to 2004	English Only Full Text
	Cerebral Damage + eye damage + pediatric	Prior to 2004	English Only Full Text
	Visual Fixation	Prior to 2004	English Only Full Text
	Visual Fixation + Children	Prior to 2004	English Only Full Text
	Visual Fixation + Children + eye damage	Prior to 2004	English Only Full Text
	Visual Fixation + Children + Cortical Visual Impairment	Prior to 2004	English Only Full Text
	Visual Fixation + Pediatric	Prior to 2004	English Only Full Text
	Visual Fixation + Pediatrics + eye damage	Prior to 2004	English Only Full Text
	Visual Fixation + Pediatrics + Cortical Visual Impairment	Prior to 2004	English Only Full Text
	Vision Loss + Pediatrics	Prior to 2004	English Only Full Text
	Vision Loss + Children	Prior to 2004	English Only Full Text
	Vision Loss + Pediatrics + Cerebral	Prior to 2004	English Only

	hemisphere		Full Text
	Vision Loss + Children + Cerebral Hemisphere	Prior to 2004	English Only Full Text
	Occupational therapy + Fixation Training	Prior to 2004	English Only Full Text
	Occupational therapy + Vision loss	Prior to 2004	English Only Full Text
	Occupational Therapy + Cortical Visual Impairment	Prior to 2004	English Only Full Text
	Ting Tsai	Prior to 2004	English Only Full Text
	Christine Roman-Lantzy	Prior to 2004	English Only Full Text
	Sharon S. Lehman	Prior to 2004	English Only Full Text
	Louis H. Ospina	Prior to 2004	English Only Full Text
	William V. Good, MD	Prior to 2004	English Only Full Text

RESULTS OF SEARCH

Table 2: Summary of Study Designs of Articles Retrieved

Level	Study Design/ Methodology of Articles Retrieved	Total Number Located	Data Base Source	Citation (Name, Year)
Level 1a	Systematic Reviews or Metanalysis of Randomized Control Trials			
Level 1b	Individualized Randomized Control Trials			
Level 2a	Systematic reviews of cohort studies			
Level 2b	Individualized cohort studies and low quality RCT's (PEDro < 6)			
Level 3a	Systematic review of case-control studies			
Level 3b	Case-control studies and non-randomized controlled trials	1	Ebscohost	Malkowicz, D. E., Myers, G., & Leisman, G. (2006).
Level 4	Case-series and poor quality cohort and case-control studies	1	Ebscohost	Alimović, S. & Mejaški-Bošnjak, V. (2011).
Level 5	Expert Opinion	1	Ebscohost	Baker-Nobles, L. & Rutherford, A. (1995).

STUDIES INCLUDED

Table 3: Summary of Included Studies

	Study 1	Study 2	Study 3
Authors	Baker-Nobles, L. & Rutherford, A.	Malkowicz, D. E., Myers, G. & Leisman, G	Alimović, S. & Mejaški-Bošnjak, V.
Design	Single Case Report	Retrospective, quasi-experimental Pre-test/post-test with non-equal groups	Cohort study
Level of Evidence	Level 5	Level 3b	Level 4
Rigor of Evidence (Ratings of Critique Scale)	1/11 on the SCED Scale	3/11 on the Pedro Scale	2/12 on the Cohort Screening Questionnaire
Purpose of Research	To show that occupational therapy treatment can help increase the child's residual vision	To see if the use of a visual stimulation program would improve the visual abilities of children with CVI in comparison to a group who did not receive visual stimulation programs	To see if the utilization of a visual stimulation program will improve functional visual abilities with children that have suffered a brain injury
Population	One 14-month old female with a CVI and left hemiparesis due to a neonatal infarction caused by perinatal coagulopathy	Experimental group: 21 subjects between the age of 13 and 120 months with CVI (perinatal and postnatal) Inclusion Criteria: Relatively intact anterior pathway and intact light reflex, visual competence level of 1, 2, or 3 at initial evaluation Exclusion Criteria: Co-existing significant progressive or degenerative neurological disorders or significant co-existing medical disorders which would affect brain function Control group: 67 children with CVI from a previous study	30 children birth-3 years of age with perinatal brain damage. Exclusion Criteria: Retinopathy of prematurity grades 3-5
Dependent Variables	Visual awareness to light, central fixation, gaze shifting and visual following and, reaching	Visual competence	Functional vision: visual fixation and attention, visual reflexes, eye movements, visual acuity, and eye alignment
Outcome Measures	Time of fixation on objects/light box, therapists observations, parent report	Developmental Profile for Sensory and Motor pathways-Visual competence portion (experimental group) and Hoyt's	Binocular corneal reflex, monocular corneal reflex, following movements, saccades (observed through

		Visual Levels (control group)	ability to switch fixation from one object to another), peripheral visual field binocularly, visual attention (subjectively), visual communication (subjectively), visual acuity (Teller acuity card or Lea Grating), contrast sensitivity using Hiding Heidi
Intervention Investigated	Fixation training utilizing: light box, toys with light and sound, and a flash light Other visual stimulation techniques: color monitor computer screen with cause and effects programs	Multi-faceted intensive treatment program. Individually designed for the child and carried out by the parents in the home. Programs were based on the visual developmental level the child was measured at. Program for light reflex*-visual fixation with a flashlight Program for Outline Perception-The child is placed in an environment with black and white checkerboard surroundings. The child spends a majority of their day in this environment. Program for outline perception*-following a penlight in a dimly lit room for 1 minute 10 times/day Program Bits and Slides: Outlines of shapes on contrasting background were shown to the child 10 times/day throughout the day Detail within a configuration: black and white or colorful images are placed in the previously described checkerboard environment Increasing detail: increased detail in pictures in the checkerboard environment Word Cards: presented 10 times/day for no more than 5 seconds. Intervention lasted for 15 months or until the child improved to levels 5, 6, or 7 on the developmental profile. **indicates fixation training*	Unspecified intervention time over a 3 year span. Treatment consisted of stimulation using every day martials, bright colors and high contrast materials, materials under UV light, and lights and lightning materials.
Control	No control group	A prior study with 67 children with CVI that did not have visual stimulation treatment	No control group
Results (p value and effect size)	No statistical results. Observations included: -Central fixation to simple	Overall treatment time was between 4 and 15 months. -2/21 improved 2 levels	Results were presented with subjective ideas. Comparison of results

	pictures for more than 1 minute on light box -Shifted gaze between a picture and the corresponding real object located on the light box -Reciprocally crept -Occasionally looked at a toy in normal light if distractions were absent or minimal -Visual learning began to occur -Parent reports increased visual awareness	-9/21 improved 3 levels -7/21 improved 4 levels -2/21 improved 5 levels -1/21 improved 6 levels The control group's times of evaluation varied from 9 months to 15 years, with an average 5.9 years. -24/67 showed no improvement -26/67 improved 1 level -13/67 improved 2 levels -3/67 improved 3 levels -1/67 improved 4 levels -0/67 improved 5 levels	indicated statistically significant results with between visual attention (p=0 z= -3.448); visual communication (p=0 z= -3.502); point of fixation (p=0 & z=-2.828); steadiness (p=- z=-3.127) and contrast sensitivity (p=0 &z=-2.946)
Author's Conclusion	The major treatment goal with infants and children with CVI is to maximize the use of residual vision so that these children have a better opportunity for learning from the environment.	Visual stimulation programs give the child the visual stimulation needed to brain improvement rather than leaving it up to environmental chance, which can facilitate improved visual functioning	Visual stimulation program which includes fixation aspects improves attention and fixation times in children with CVI. These stimulation programs should be individualized for each child.

IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARC

Overall Conclusions:

PICO Question: Is fixation training effective compared to no treatment to improve residual vision and optimize visual responses in children from birth to 10 years old with cortical visual impairments?

Key Terms:

Fixation Training: Fixation training is an intervention used to help a child fixate on an object for a sustained period of time utilizing any of the following techniques: attend to the child's preference of color or objects and light. The therapist utilizes the child's preferences to motivate the child to not only see, but visually attend to the object. When the child fixates on the object it is thought that the child will establish a focal point, which will facilitate clear vision, promote exploration of the environment, refine performance in ADLs and improve overall quality of life. Having the child fixate on an object during play or an ADL task will help to re-establish lost connections within the brain and increase visual attention of the child.

Functional/residual vision: Person's current visual skills and abilities to perform daily tasks, and how the individual applies his/her vision in real life activities or environments. Specific examples include fixation, visual tracking, light orientation, motion perception, and luminance discrimination. Assessments of functional vision include standardized and non-standardized tests during play to assess visual functions and observe the child's use of vision with everyday situations.

Visual stimulation program: overall intervention used when treating CVI including fixation training as well as using high and low contrast within the environment, tactile cues, and light reflex.

Results: Similar Findings

- Residual/functional vision was measured in all three studies and was found to improve however using different outcome measures. Baker-Nobles & Rutherford, 1995 used time of fixation on objects/light box, therapist's observations, and parent report. Malkowicz, D. E., Myers, G. & Leisman, G used the Developmental Profile for Sensory and Motor pathways (visual competence portion). Alimović & Mejanski-Bosnjak, 2011 used binocular corneal reflex, monocular corneal reflex, the ability to follow movements, observing saccades through ability to switch fixation from one object to another, peripheral visual field binocularly, visual attention, visual communication, visual acuity using Teller acuity card or Lea Grating, and contrast sensitivity using Hiding Heidi.
- All three studies individualized the visual stimulation intervention plan to each participant's visual deficits to determine there was improvement in fixation abilities.
- All three of the studies utilized fixation training in conjunction with other forms of visual stimulation to improve residual/functional vision.
- Two of the three studies (Baker-Nobles & Rutherford, 1995 & Alimović & Mejanski-Bosnjak, 2011) measured fixation time and from this they found that fixation training in conjunction with other forms of visual stimulation training (outline bits & slides; checkerboard; ultraviolet, tactile cues, and light reflex) improved fixation time.

Results: Different Findings

- All three studies had different environments in which the intervention was administered as well as different levels of expertise of administrators (some not even noted) which may impact the level of improvement in residual/functional vision that was reported.
- Duration and compliance for all three studies were different or not indicated therefore results cannot be attributed to the quantity and/or quality of the intervention.
- Outcome measures used were different in all 3 studies, which could impact the ability to compare and synthesize the studies results.

The effectiveness of visual fixation training in children age birth to 10 years old was not tested alone; however fixation training in conjunction with other means of visual stimulation programs showed improvements in residual/functional vision based on the three articles despite differences in outcome measures, intervention time, intervention protocol, variable measured, and treatment schedules.

One of the articles was a case report level 5, another article was a quasi-experimental level 3b, and the third article was a cohort level 4. This results in a grade D evidence for the emerging research in suggesting the use of fixation training to improve residual vision in children birth to 10 years old with CVI/ brain damage.

Boundaries:

A total of 52 children ranging from birth to 10 years old at start of intervention participated in these three studies. All participants were diagnosed with

perinatal or postnatal brain damage and/or CVI and had a similar diagnostic description: blindness due to bilateral visual loss within the brain with normal pupillary responses and normal eye examinations with no other indications of eye structural abnormalities (article 1, 2, & 3). Exclusion criteria differed between the studies including retinopathy of prematurity stages III, IV, & V, co-existing significant progressive or degenerative neurological disorders, or significant co existing medical disorders influencing the brain.

Implications for Practice:

Based on the results of the three articles it cannot be concluded that fixation training alone helps improve residual/functional vision in children birth to 10 years old with diagnosed brain damage and/or CVI. Overall treatment time ranged from 4 months to 3 years. Due to extreme differences in the three articles for the length of a visual stimulation program (that includes fixation training), the most effective length of intervention is individualized for each participant. Individual treatment session time and number of sessions needed for visual stimulation programs that include fixation training to cause improvement in residual/functional vision cannot be determined from these articles. Characteristics of visual stimulation programs used in the three articles include fixation training using bright colors, light boxes, flashlights on toys in dark rooms, toys with lights, cause and effect computer programs, and objects of interest to child.

REFERENCES

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Baker-Nobles, L., & Rutherford, A. (1995). Understanding cortical visual impairment in children. *The American Journal of Occupational Therapy*, *49*(9), 899-903.

Malkowicz, D. E., Myers, G., & Leisman, G. (2006). Rehabilitation of cortical visual impairment in children. *International Journal of Neuroscience*, *116*(9), 1015-1033.

Related Articles (not individually appraised)

Roman-Lantzy, C. (2007). *Cortical visual impairment: An approach to assessment and intervention*. New York, NY: AFB Press.

Tsai, L., Meng, L., Wu, W., Jang, Y., & Su, Y. (2013). Effects of visual rehabilitation on a child with severe visual impairment. *American Journal Of Occupational Therapy*, *67*(4), 437-447.