Discussion of the findings from the 2D image study for students with CVI
Object identification in cerebral visual impairment characterized by gaze behavior and image saliency analysis.

Perkins School for the Blind: CVI for the TVI
Terms in This Study

- **Saliency**: what stands out from the bottom-up visual processing perspective (i.e. color, edge orientation, intensity). What stands out. This is what we are measuring.

- **Semantic Features**: The features that makes something what it is. What makes a cup a cup? A horse a horse? (“Salient Features” - Christine Roman-Lantzy). Relies on prior experience and learning.

- Sometimes both these terms are used interchangeably. For this study we are using “saliency” to refer to bottom-up processing.
What is this?

“bicycle”

“scissors”
Anecdotal Observations

• Images tend to be more difficult to interpret than objects for our students with CVI.

• Color, realistic photographs tend to be easier to interpret than other kinds of images while black and white, abstract line drawings tend to be the most difficult.

• This loose “hierarchy” of difficulty is supported in the literature on brain-based visual impairments (Farrah, 97).
Why are images more difficult than objects?

Top-Down
Semantic features
(wheels, hood, windshield)

Bottom-Up
Color
Luminance cues
Visual texture
Actual size
The progression from object, to photograph, to illustrations, to black and white line drawings results in the increasing “impoverishment” of the lower order features. (Farrah, 93)
Why is this Important?

Picture It!
Read each sentence and look at the pictures. Draw a line to connect each picture to the sentence it goes with.

- I have one fish.
- He was not in school or at home.
- This is from my house by the beach.
- I had milk and one cookie.
- They have to be brother and sister.
13 children with CVI

- Color Photo: 73%
- Realistic Color: 70%
- Abstract Color: 58%
- Realistic Black & White: 58%
- Abstract Black & White: 47%
Number of students CVI for whom that category of images was their best or tied for best.
“Swimming Pool”
“Princess”
“bus driving down the road”
“hook”
“Dinosaur”
“teeth”
“remote”
Why we do research

Add Difference between Study and
The 2D Image Study
Study design

- 12 objects, each with 5 possibilities:
  - Abstract outline (B&W)
  - Realistic outline (B&W)
  - Abstract color
  - Realistic color
  - Color photograph
- 6 animals and 6 inanimate objects

Matched by features such as size and canonical view. (Total: 60 images, presented in pseudo random order)
Study design

Task and measures
- Participants viewed the image and verbally identified the object, then click the spacebar to move on
  - Reaction time
  - Identification Accuracy
- Eye-tracking used Tobii 4C
  - Recorded gaze pattern
  - Search area
  - Number of fixations
  - ROC

Participants
- 50 control (age: 15.66 yrs, verbal IQ 112.02)
- 50 CVI subjects (13.54 yrs, verbal IQ 89.53)
- Boston, US and Brescia, Italy
Receiver operating characteristic (ROC)

- How does a participants gaze pattern compare with the predicted gaze pattern (based on feature saliency)
- GBVS = Graph-Based Visual Saliency map
  - based on three main low-level features: color, edge-orientation, and intensity
Compare gaze pattern of CVI and control subjects
Results

Success Rate*  
Reactivity Time*  
Receiver Operating Characteristic*  
Correct vs Incorrect Responses

Visual Search Area*  
Number of Fixations*

*Mean group differences were statistically significant for all outcomes.
Conclusions

- As images become more abstract or the color is removed, children with CVI become less likely than the control subjects to correctly identify the objects.
- Children with CVI take longer to correctly identify objects, and they tend to search more of the image and fixate on more features of the object before they are able to identify the object.
- They spend more time looking at the image and make more fixations when they have trouble identifying the object → this indicated they will persist, even when recognition is not automatic.
- Color is important for helping children with CVI identity cartoon representations.
- Images also lack context, relative size, and texture – features that children with CVI may rely on when identifying objects in the real world.
Future directions for research

- ROC analysis based on semantically-relevant features rather than salient features
- How does a cluttered background affect children’s ability to identify cartoon/abstract images?
- Feedback from kids, parents, and teachers
Future research stems from student’s access

Our understanding of the access a student with CVI has to all aspects of life is developing. From the need to provide an accessible educational environment comes areas of future research. Gaining a better understanding on access to materials presented on a smart board, or the benefit of certain accommodations used by teachers helps to provide a framework of strategies and approaches that may be suited to students with CVI based on their individual needs.
What does this mean in the classroom?
Imagine a classroom...

How much of the environment is visual accessed based?

Are the materials intended to supplement/reinforce teaching?
Be mindful of the visual environment

A student with CVI, will have different access to visual materials than a typically sighted peer. These differences will be individual to the student but may impact: recognition, response time, and the field they scan to take in the image.
What is the lesson goal
Important to recognize accessibility at varying distances
Decreased incidental learning impacts a student with CVI’s. This impacts the student’s access to education, and learning style. These should be considered, individually, through evaluation to determine the accessibility of materials, images and the environment.
Each student will be impacted individually

There is no one size fits all to any strategy or methodology for students, especially those with CVI. From the 2D image study, Practitioners, teachers and caretakers of students with CVI should be actively evaluating and data collecting on the accessibility of the environment and related images.

Evaluate the methodology of form accessibility for your students
The image shows a set of cards with letters and pictures corresponding to different words. The letters are V, W, X, Y, Z, and the words are car, cloud, squirrel, crayon, top, van, wind, fox, yellow, and zebra. There are also images of a lion and a drawing of a lion with a caption that says, "Lion, lion, what do you say?" and another image with the text, "There is a tiger in my den."
Assessing Visual Processing Abilities in Cerebral Visual Impairment

The Laboratory for Visual Neuroplasticity
Massachusetts Eye and Ear
Harvard Medical School

Please visit our website for more information about ongoing research programs
https://merabetlab.meel.harvard.edu/merabetlab.html

Research Project Description

We are interested in investigating how individuals with a brain-based visual impairment perceive the world around them. To study this, we have designed approaches to assess functional vision abilities using novel visual tasks.

These tasks use virtual reality and eye tracking that follow the movement of the eyes. The tasks are designed to investigate how children, adolescents, and adults process complex visual information under different conditions related to environmental complexity and sensory processing.

This study will help us better understand how individuals with visual impairment see and interact with the world around them and provide further characterization of visual perceptual abilities beyond standard clinical testing. Results are shared with participants and families.

General Eligibility Criteria:

- Aged 7 or older and having a diagnosis of early onset visual impairment associated with Cerebral/cortical visual impairment (CVI) AND visual acuity sufficient to perform tasks (generally 20/60 Snellen equivalent or better).

Other Eligible participants:

- Diagnosis of attention-deficit/ hyperactivity disorder (ADHD) with (or corrected) normal visual acuity and no history of visual impairment.

Participation includes:

- Approximately 1 to 2 hours per study
- Compensation for participation, parking, and travel expenses reimbursement provided

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References


