

Relationship Between Functional Vision and Brain Function in CVI: Putting it All Together

3:15-4:00, 4-4:30: Discussion

Corinna Bauer

MASSACHUSETTS SCHENCKS EYE
EYE AND EAR RESEARCH INSTITUTE

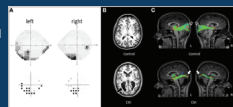
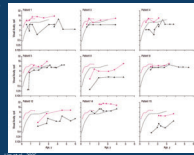
HARVARD MEDICAL SCHOOL Department of Ophthalmology

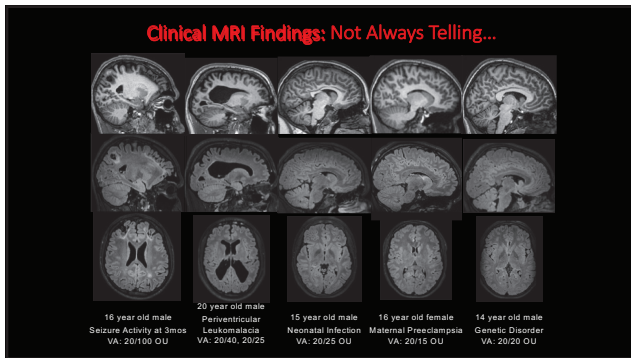
How does the brain process visual information in the case of CVI?

- Relationship between brain structure and visual processing
 - MRI, Ultrasound, CT
- Relationship between brain function and visual processing
 - EEG, MEG, functional MRI

Brain structure and CVI severity?

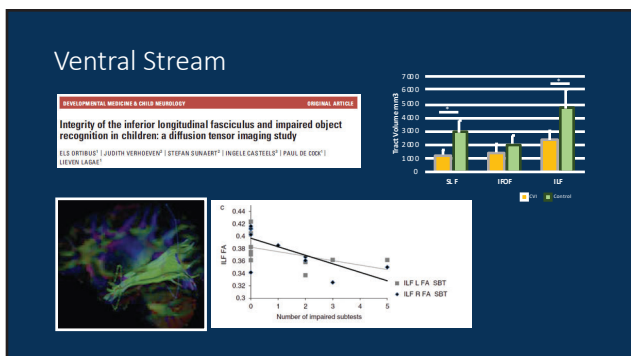
- Few studies exist that empirically evaluate the link between brain structure and CVI severity
 - Most focus on acuity or visual fields
 - But, is acuity a good marker for CVI severity?
- Damage to optic radiations corresponds to visual field restriction
- Many published studies mention improvements in visual acuity in some children with CVI
 - Watson et al., 2007, Swati et al., 2017, Lim et al., 2005...
 - Can we predict the extent of improvement in visual acuity or who will improve?
 - Still unknown whether improvement is related to intervention, underlying brain lesions, etc.



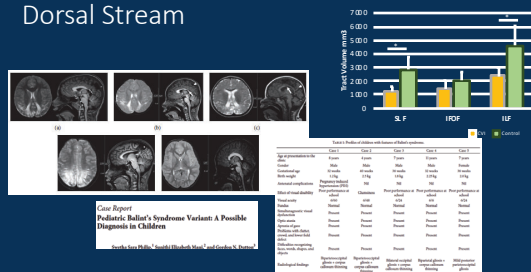


White matter pathway changes in CVI

- Many etiologies of CVI are associated with changes in white matter development
 - E.g. PVL – damage to pre-myelinating oligodendrocytes
 - May result in long-term changes in myelin
 - Affects speed and efficiency of transmission of action potentials
 - May impede network formation and strengthening
 - Ultimately, each of these may impact visual processing speed and abilities



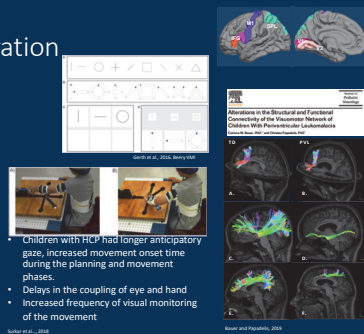
Dorsal Stream



Visuomotor Integration

- Visuomotor Integration (i.e. eye-hand co-ordination) is often affected in children with cerebral palsy, PVL, and other conditions associated with CVI.

- Children with CVI may demonstrate unusual looking and reaching patterns
 - Neural correlates of this have yet to be determined
 - VMI network is widespread
 - Monkeys with lesions to the thalamus have also shown the same behaviour



Navigation and Spatial Processing

- Magic Carpet navigation test
 - Derived from the Corsi Block-tapping Task
 - Visual spatial memory
 - Repeat spatial sequences of increasing length by tapping cubes in the same sequence as the examiner
 - Required mental rotations and executive function
 - Spatial sequences presented in locomotor space
 - Subject required to repeat the sequence by walking on the tiles, increase of tapping on cube
- Performance affected by lesion extent and distribution
 - Right frontal lobe in particular for CBT
 - Navigation when lesion extended to central white matter and/or right frontal lobe
- Overall impairment in short-term visual spatial memory
 - Worse in the case of bilateral lesions

Navigation strategies as revealed by error patterns on the Magic Carpet test in children with cerebral palsy

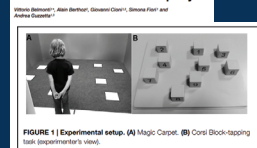
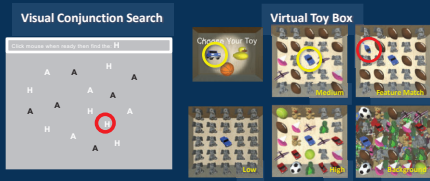


FIGURE 1 | Experimental setup. (A) Magic Carpet. (B) Corsi Block-tapping (top, participant's view).

Psychophysical Assessments of Functional Vision: Visual Search



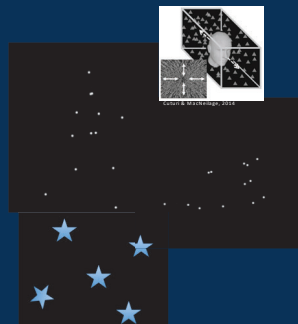
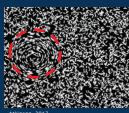
Motion Processing

- The dorsal stream may be particularly vulnerable to early brain injury
 - "dorsal stream dysfunction"
- Motion is a key dorsal stream function
- Often reported as abnormal in CVI
 - Difficulty seeing fast-moving objects
 - Inability to see objects unless in motion
- Lots of different types of motion to evaluate

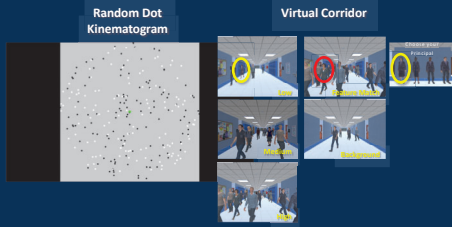


Types of Visual Motion

- Optic flow
- Biological motion
- Structure from motion
- Motion – visual attention



Psychophysical Assessments of Functional Vision: Motion/Optic Flow



What we still need to figure out

- How are these changes related to functional vision?
- What is the influence of etiology?
- What are the long-term effects of early changes to brain structure in terms of visual development?
- Do habilitation programs alter brain morphometry?
- What about specific white matter pathways?

Discussion
