Neural correlates of the motion-defined form deficit in the fellow eye of adults with amblyopia

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Abstract Submission

Authors:

Akosua Asare[1], Nolan Chem[1], Hee Yeon Im[1], Deborah Giaschi[1]

Institutions:

[1]University of British Columbia, Vancouver, Canada

First Author:

Akosua Asare
University of British Columbia
Vancouver, Canada

Co-Author(s):

Nolan Chem
University of British Columbia
Vancouver, Canada
Hee Yeon Im
University of British Columbia
Vancouver, Canada
Deborah Giaschi
University of British Columbia
Vancouver, Canada

Introduction:

Amblyopia is a common developmental visual disorder that is defined clinically as reduced visual acuity in a healthy eye that cannot be immediately corrected with lenses. However, amblyopia is also known to disrupt motion perception even in the clinically-unaffected fellow eye (Ho et al., 2005). Psychophysical studies have reported deficits for slow but not faster speeds of motion (Hayward et al., 2011), and these deficits persist after standard treatment with occlusion therapy (Giaschi et al., 2015). Evidence from electrophysiological and psychophysical studies suggests that slow and medium-to-fast speeds of motion are processed by different mechanisms (reviewed in Meier et al., 2018). The purpose of this study was to determine the effect of speed on the cortical regions activated during a motion-defined form task. We have shown previously that this task is very sensitive to disruption by amblyopia.

Methods:

We used task-based fMRI to measure brain activation by slow (0.1 deg/s) and medium (5 deg/s) speeds of motion-defined form in adults treated for amblyopia and healthy controls. Vertical and horizontal motion-defined rectangles were created by moving dots inside the rectangle in one direction and dots outside the rectangle in the opposite direction at the same speed. For each participant, the percentage of dots moving in the same direction was reduced to determine the psychophysical coherence threshold for correctly discriminating the orientation of the rectangle for each speed. These thresholds were used to balance the difficulty of the fMRI task across speeds and participants. The stimuli were viewed through the fellow eye, which had normal visual acuity, in the participants with amblyopia or through a matched eye in the controls. The other eye was occluded with an opaque patch. Following the main task, functional localizers were used in separate scans to identify the motion-sensitive area V5/MT+ (moving vs. stationary dots) and the object-selective lateral occipital complex (objects vs scrambled images) for each participant. Data were acquired on a GE 750 3.0 Tesla scanner with a 32-channel Nova Medical head coil and multiband EPI sequences. Data were preprocessed and analysed using FEAT in FSL. Whole-brain voxel-wise activation was modeled at the individual level, and mixed-effects analysis was used to evaluate contrasts between the medium and slow speeds of motion-defined form, relative to randomly moving dots without a motion-defined rectangle.

Results:

Activation in the control group was similar for medium and slow speeds of motion, and included greater activation in bilateral V5/MT+, posterior occipital and posterior parietal areas for both medium and slow speeds of motion-defined form than for random motion of the same speed. This is consistent with our previous results (Meier et al., 2018). Our novel finding is that activation in the amblyopia group was similar to that of controls at the medium speed, but was greatly reduced at the slow speed. This difference was evident in spite of similar visual acuity and task difficulty between the groups.

Conclusions:

The speed-tuning of the behavioural deficit in motion-defined form perception in the fellow eye in amblyopia is evident in task-based fMRI activation maps. Regions of the dorsal visual stream appear to underlie this deficit.

Modeling and Analysis Methods:

Activation (eg. BOLD task-fMRI) [2]

Perception, Attention and Motor Behavior:

Perception: Visual [1]

Keywords:

Development
DISORDERS
FUNCTIONAL MRI
Perception
Vision

[1|2]Indicates the priority used for review

My abstract is being submitted as a Software Demonstration.

No

Please indicate below if your study was a "resting state" or "task-activation" study.

Task-activation

Healthy subjects only or patients (note that patient studies may also involve healthy subjects):

Patients

Was any human subjects research approved by the relevant Institutional Review Board or ethics panel? NOTE: Any human subjects studies without IRB approval will be automatically rejected.

Yes

Was any animal research approved by the relevant IACUC or other animal research panel? NOTE: Any animal studies without IACUC approval will be automatically rejected.

Not applicable

Please indicate which methods were used in your research:

Functional MRI
Structural MRI
Behavior

For human MRI, what field strength scanner do you use?

3.0T

Which processing packages did you use for your study?

FSL

Provide references using author date format

Giaschi, D. (2015), 'The effect of occlusion therapy on motion perception deficits in amblyopia', Vision Research, 114, pp. 122-134.
Hayward, J. (2011), 'Effects of speed, age and amblyopia on the perception of motion-defined form', Vision Research, 51, pp. 2216-23.
Ho, C. (2005), 'Deficient motion percep-tion in the fellow eye of amblyopic children', Vision Research, 45, pp. 1615-27.
Meier, K. (2018), 'Neural correlates of speed-tuned motion perception in healthy adults', Perception, 47, pp. 660-683.