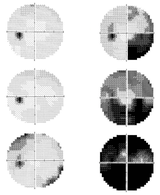
Do ocular movements compensate for visual field defects to potentially allow safe driving?

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Background:

Patients often suffer visual field defects after epilepsy surgery. Normal vision is not static and uses eye saccades to construct visual perception. However, current field testing (Esterman) uses static fixation, and prevents many post-surgical patients from driving, despite seizure freedom. We hypothesise that permitting normal eye saccades can partially compensate for field defects during testing.



Objective:

This study investigates the impact of fixed versus roaming fixation on the performance of normal individuals and those with surgically-induced visual field deficits in binocular central visual field testing.

Methods:

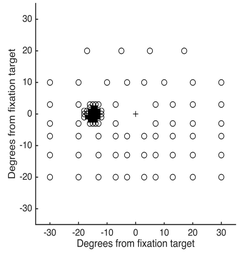
Control participants (n=8) had no known visual field deficit. Experimental participants (n=6) had a trans-Sylvian amygdalohippocampectomy for mesial temporal lobe epilepsy. The binocular Esterman test was replicated with a central fixation target, to obtain a baseline measure of the visual field and record typical eye movement behaviour. The central fixation target was then removed so a measure of visual field could be obtained under intentionally generated poor fixation.

Finally, the fixation target was re-applied, and stimuli locations were randomly shifted by up to ±5°. The random jitter of the stimuli loci was by 5° in order to correlate directly with the typical magnitude of driving saccades (Bahnemann et al., 2015). Control participants were tested monocularly, using the physiological blind-spot as a simulated scotoma.

Results:

Each test gave us a visual representation of the subject's monocular visual field (*Figure 1*). The clear circles correspond to the location of stimuli that were seen, and the filled-in points correspond to stimuli that were not seen. *Figure 1i* is a typical representation of a control participant who has had their left monocular visual field tested. As can be seen by the filled-in points there was a blind-spot present at approximately 15° temporal.

Figure 1i: Control participant, fixation



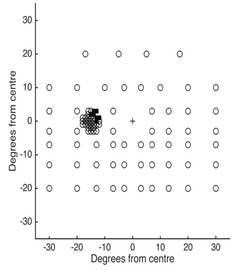


Figure 1ii: Control participant, no fixation

Figure 1ii is the same control participant without a fixation target present. As can be seen in the graphs, the blind-spot size has decreased and shifted nasally. Our eye movement analysis suggests that this occurred due to an increase in the horizontal range of eye movements performed during each respective test.

All participants made saccadic movements despite instruction to maintain a fixed gaze. Control participants saw 5% more stimuli under intentionally generated poor fixation, and 10% more with simulated eye movements *(Figure 2*), implying a functional reduction in blind-spot, a direct result of increased horizontal eye movements. Surgical participants with central deficits also showed improvement.

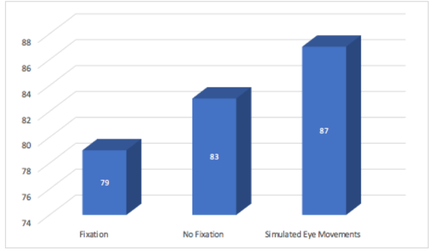


Figure 2: Average number of points seen under each specific condition

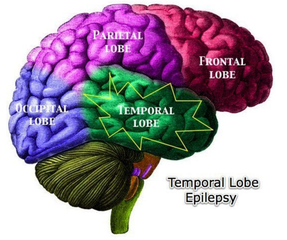
Participants with field loss due to epilepsy surgery adhered to central fixation less well than the control participants, even under conditions that promoted stable fixation. Instability was confined to horizontal eye movements, but it was substantial; up to ±10° in some cases.

These results, when both the eye movement data and the number of stimuli seen with each of the three conditions are considered, suggest that eye movements do compensate for scotomas.

Conclusions:

Allowing saccades to simulate eye movements during driving resulted in a functional decrease in the blind-spot and field defects.

Based on our findings it is difficult to objectively determine to what degree ocular movements compensate for visual field defects. However, it is clear that the testing procedure to decide driving capability is inadequate for assessing the functionality of its subjects' vision. Indeed, the current assessment of driving capability may overestimate functional visual field loss and could disqualify patients from driving who successfully use eye movements to compensate.



References:

Bahnemann M, Hamel J, De Beukelaer S, Ohl S, Kehrer S, Audebert H, Kraft A, Brandtup SA. (2015). Compensatory eye and head movements of patients with homonymous hemianopia in the naturalistic setting of a driving simulation. J Neurol. 262:316–325, DOI 10.1007/s00415-014-7554-x

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