A Novel Paradigm for Vision Functionometry in Glaucoma

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PURPOSE

• Results of standard automated perimetry testing may have a poor relationship to visual experience in daily living.
• We propose a novel approach to vision functionometry that examines the active use of visual information in complex visual environments.
• For this purpose, we developed an active visual search task requiring natural saccadic vision to detect the appearance of matching object pairs in an evolving display.

METHOD

• During this pilot session, four sizes of Gabor patches with four possible different orientations were presented to the screen (20-inch LCD monitor positioned 60 cm from the eyes). Five Gabor patches were always visible on a gray computer screen background at pseudo-randomly selected positions in a 3x4 grid. Every 1.66 seconds a new Gabor patch appeared and the longest-displayed patch disappeared.
• The subject (n=1) performed an active search task, indicating by button press the infrequent (15% probability) occurrence of a pair of Gabor patches matching in size and orientation.
• The session comprised 1,886 stimulus presentations (285 targets, 1,601 non-targets).
• Infrared eye gaze position data were obtained from the left eye while 256-channel EEG (brain), EMG (muscle), and EOG (eye) activity data were recorded.
• We developed a method, ITrack, to identify exact saccade onsets and offsets (see steps below; developer, Özgür Yiğit Balkan).
• Event-related potential data were analyzed using EEGLAB [1], MoBILAB [2], and custom Matlab scripts.

RESULTS

• There were 10,266 saccades in 1,886 trials (3,138 sec), equivalent to 3.63 saccades/sec.
• There were 221 hit and 64 missed matches. Response accuracy was 78%; mean reaction time, 959 ms (±321 ms SD). Subject was a young adult with no history of glaucoma.
• Smaller Gabor patches and longer distances between the targets were associated with missed responses and prolonged reaction times.

CONCLUSION

• The task efficiently elicited saccades across the visual field.
• ‘Miss’ trials exhibited inhomogeneity in missed target positions and gaze trajectory coverage, suggesting individualized visual search habits and/or strategy.
• We hypothesize that alteration in or loss of visual field should prompt spatially compensatory saccades in glaucoma patients, with accompanying differences in cortical EEG activity.
• The proposed task and analysis, combined with EEG source imaging, could yield a useful test battery for vision functionometry in glaucoma and other eye diseases.


Commercial Relationships: FAM: Alcon Laboratories, Inc. (F, R), Bausch & Lomb (F), Carl-ZeissMeditec (F, R, C), Heidelberg Engineering (F), Merck, Inc. (F), Allergan, Inc. (F, R, C), Sensimed: (F), Topcon, Inc. (F), Reichert, Inc. (F, R), National Eye Institute (F), Novartis (C)

Support: Gift from the The Swartz Foundation, NIH Grant EY21818 (FAM), and an unrestricted grant from Research to Prevent Blindness, NYC, New York