EFFECT OF DIFFERENT STIMULUS CONFIGURATIONS ON THE VISUALLY EVOKED POTENTIAL (VEP)

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INTRODUCTION

- Conventional visual field (VF) testing is subjective, time consuming, frequently unreliable, and may have poor repeatability. Due to these problems, VF testing is often called into question.
- Furthermore, any population having cognitive impairment cannot perform well with subjective VF testing. They may not understand and/or remember the instructions. In addition, they may have attentional limitations.
- Moreover, any population having fixational eye movement problems may not be able to maintain accurate fixation for a prolong period during VF testing (e.g., 5 minutes or so).
- VEP circumvents the above issues.
- VEP is an objective, rapid, repeatable, non-invasive method to quantify visual function, and furthermore can be used to correlate with conventional psychophysical results.
- The purpose of this study was to assess the effect of different stimulus configurations on the amplitude of the pattern visual evoked potential (VEP) as a form of objective VF testing.

METHODS

- Nine adult, visually-normal individuals participated in the study.
- Five subjects participated in each of the 3 experiments and had a mean age of 31.1 years (SD = ±14.2).
- The Diopsys™ NOVA-TR system (Diopsys, Inc., Pine Brook, New Jersey, USA) was used to generate the checkerboard pattern stimulus, as well as to analyze the VEP data.
- The VEP amplitude and latency were recorded from over the primary visual cortex (V1) using one Grass gold active-channel electrode, one reference electrode, and one ground electrode.
- Subjects viewed the test field binocularly at a distance of 1 meter.
- A checkerboard test pattern (64 X 64 black and white checks, 85% contrast, 64 cd/m^2 luminance, 20 second stimulus duration, and 2 Hz temporal frequency) with a central fixation target was used.
- The VEP amplitude and latency were assessed for each of the three stimulus configurations: In each experiment, the findings were compared with the standard full-field (17 H X15 V degrees) stimulus (Figure 1).

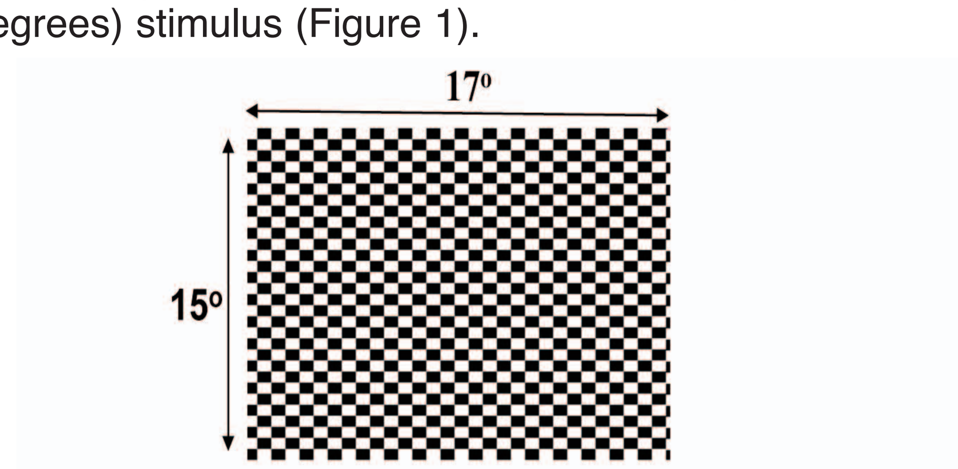


Figure 1: Standard full-field checkerboard pattern stimulus.

Experiment 1

- The VEP amplitude and latency were assessed for the central circular stimulus increasing incrementally in diameter from 1 to 15 degrees in 6 steps, i.e., 1^0, 2^0, 4^0, 6^0, 8^0, 12^0, 15^0 (Figure 2).

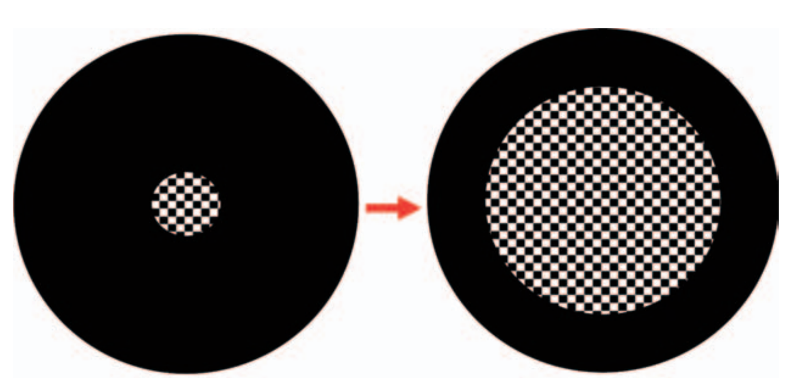


Figure 2: Circular stimulus increasing incrementally in diameter from 1 to 15 degrees in 6 steps (1^0, 2^0, 4^0, 6^0, 8^0, 12^0, 15^0).

Experiment 2

- The VEP amplitude and latency were assessed for the central annular stimulus with the inner radius increasing incrementally from 0.5 to 7.5 degrees in 6 steps, i.e., 0.5^0, 1^0, 2^0, 3^0, 4^0, 6^0, 7.5^0 (Figure 3).

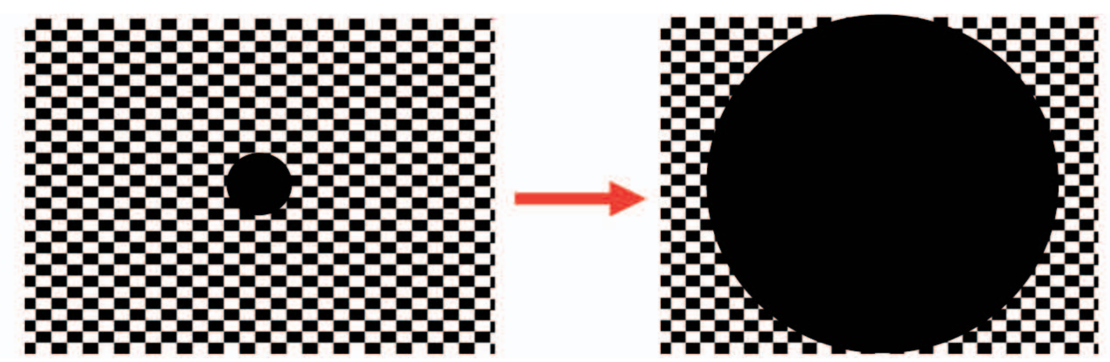


Figure 3: Central annular stimulus with the inner radius increasing incrementally from 0.5 to 7.5 degrees in 6 steps (0.5^0, 1^0, 2^0, 3^0, 4^0, 6^0, 7.5^0).

Experiment 3

- The VEP amplitude and latency were assessed for the simulated hemi-field (right, left) and quadrant (upper right, upper left, lower right, lower left) visual field defects (Figure 4).

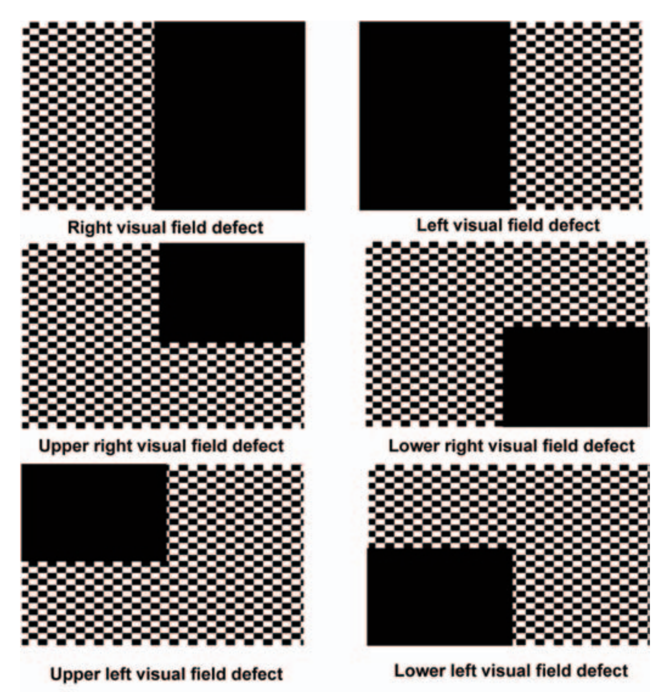


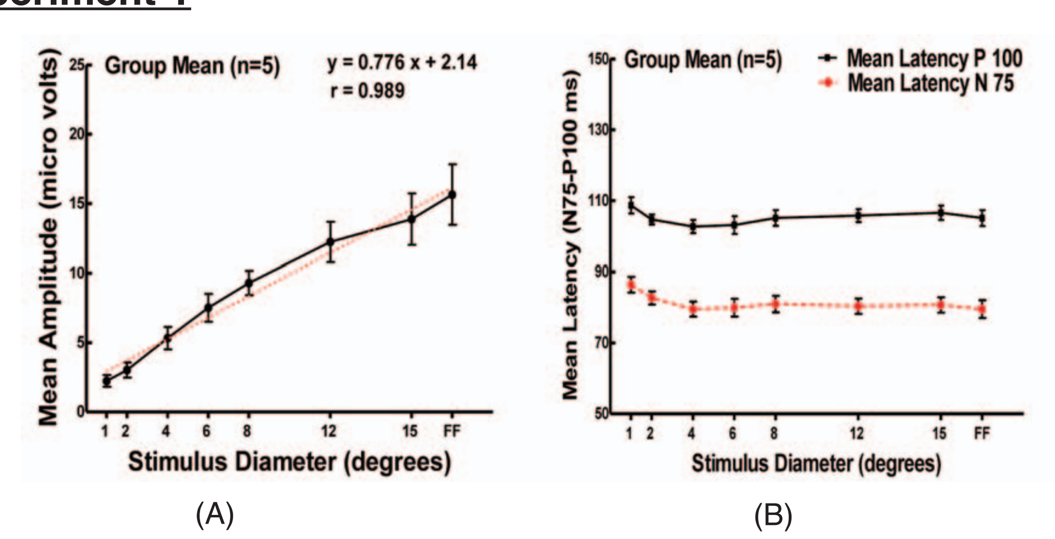
Figure 4: Stimulated visual field defects

- 5 test trials for each stimulus configuration were conducted, each on a separate day to assess response repeatability, in a counterbalanced manner.
- Changes in the group and individual mean amplitude and latency were used for the primary analysis.

RESULTS

- For nearly all changes in the stimulus configurations across the 3 experiments, latency was relatively robust.

Experiment 1

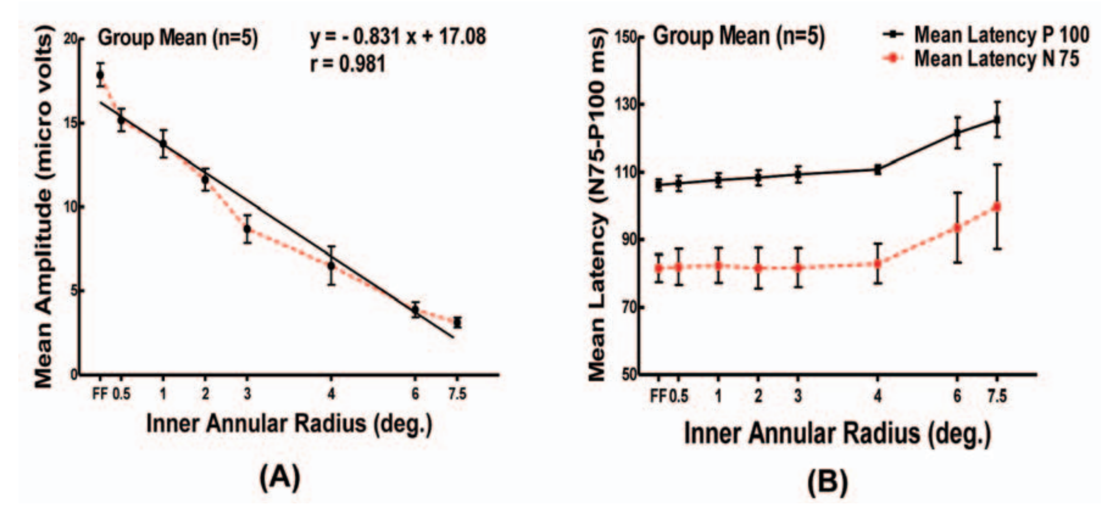


Experiment 1: Plots A, B present increasing stimulus diameter (degrees) versus VEP amplitude and latency, respectively. Plot A presents the group data (n = 5) ± 1 SEM VEP amplitude and related linear regression. Plot B presents the group data (n = 5) ± 1 SEM VEP latency at N 75 – P 100. FF represents full-field.

- There was a *linear increase* in amplitude with increase in stimulus diameter.
- Linear regression analysis revealed that the slope ranged from +0.56 to +1.07 (r = +0.97 to +0.99) in the individual subjects and was +0.78 (r = +0.99) in the group.

Experiment 2

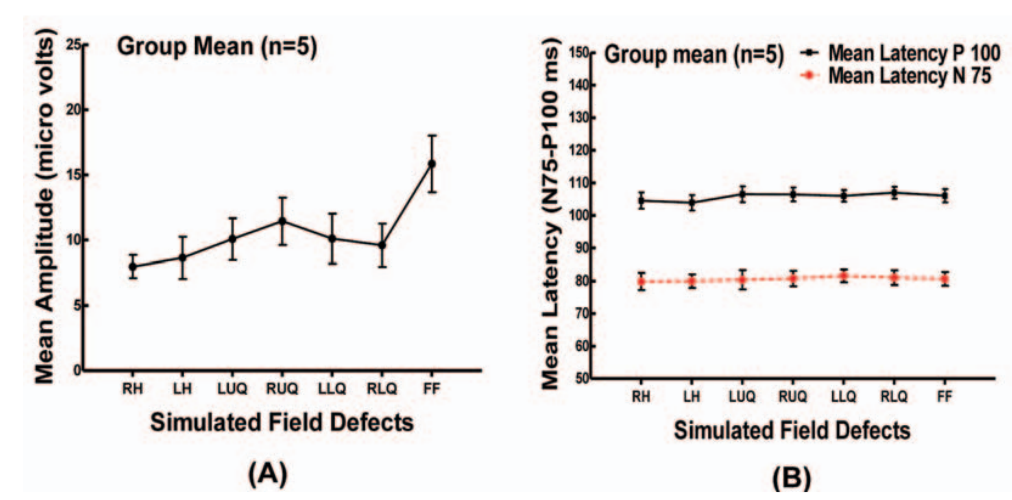
- Similarly, for the central annular stimulus, there was a *linear decrease* in the amplitude with increase in stimulus inner radius.
- Linear regression analysis revealed the slope ranged from -0.97 to -0.65 (r = +0.93 to +0.99) in the individual subjects and was -0.83 (r = +0.98) in the group.
- Mean latency was increased for the two largest inner annular radii only, i.e., 6 and 7.5 degrees.



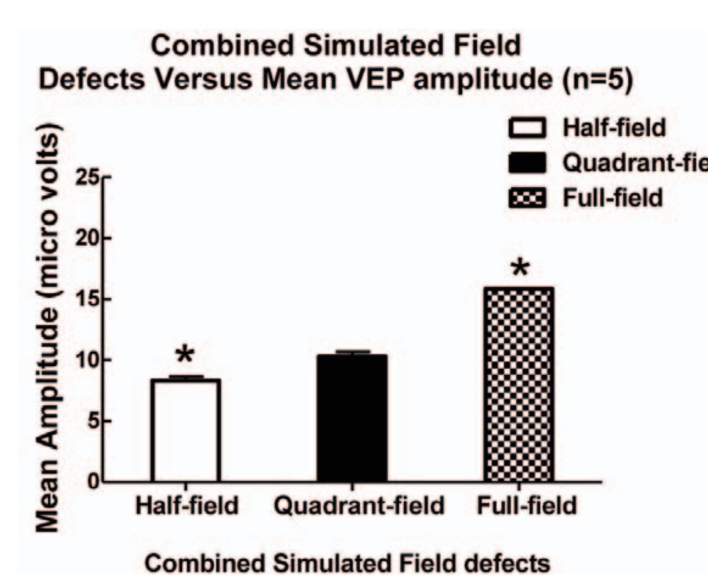
Experiment 2: Plots A, B present increasing inner annular radius (degrees) versus VEP amplitude and latency, respectively. Plot A presents the group data (n = 5) ± 1 SEM VEP amplitude and related linear regression. Plot B presents the group data (n = 5) ± 1 SEM VEP latency at N 75 – P 100. FF represents full-field.

Experiment 3

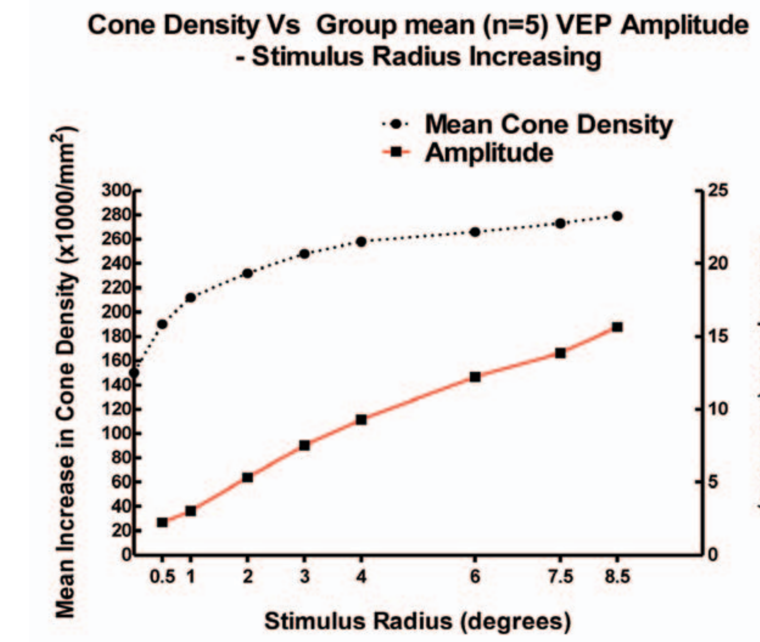
- For the simulated hemi and quadrant visual field defects, response amplitude was significantly greater for the simulated quadrant than the hemi-field defect, but it was only linearly additive in 3 of the 5 subjects.



Experiment 3: Plots A, B present simulated visual field defects versus VEP amplitude and latency, respectively. Plot A presents the group data (n = 5) ± 1 SEM VEP amplitude. Plot B presents the group data (n=5) ± 1 SEM VEP latency at N 75 – P 100. RH, LH, LUQ, RUQ, LLQ, RLQ, FF represents, right hemi-field, left hemi-field, left upper quadrant, right upper quadrant, left lower quadrant, right lower quadrant, and full-field, respectively.



Experiment 3: Presents combined simulated field defects versus mean VEP amplitude in micro-volts. Plotted is the mean +1SEM. * = statistically significant difference.



CONCLUSION

- There was linear summation of the cone-mediated VEP response to the circular and annular stimulus area changes.
- The quadrant field findings suggested greater individual variability than for the other 2 stimulus configurations.
- The above results provided evidence that the VEP method can be used clinically to assess visual field defects.
- VEP findings could be compared with conventional perimetry to confirm the magnitude and type of visual field defect.
- The results of the present study will be used to develop protocols for objectively assessing residual visual field functionality in ocular and neurological conditions such as glaucoma, macular degeneration, retinitis pigmentosa, stroke, and traumatic brain injury, as well as to assess hemi-retinal suppressive effects in constant strabismus.
- These results confirm and extend earlier studies (see below)

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Acknowledgement

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