Clinical visual-field testing, or perimetry, is a critical and primary technique used to assess for visual-field defects that are present in many clinical patients [1, 2]. Distinct visual-field defects are commonly found in several retinal diseases, such as glaucoma, retinitis pigmentosa, and age-related macular degeneration [1, 3], as well as in several neurological conditions, e.g., acquired brain injury [4], and these may be small in extent in some cases.

In addition, there is one type of visual-field defect, referred to as the “swiss cheese defect”, in which “patchy” and irregularly-shaped visual-field areas with variably reduced visual sensitivity are found [5, 6], which may be difficult to detect. This type of defect is common in patients diagnosed with glaucoma [5], cortical visual impairment [7], hypoxic or anoxic brain insult [8], and traumatic brain injury (TBI) [9].

However, visual-field test findings have been called into question over the past several decades [e.g., 8, 9]. The key criticism is that they exhibit considerable variability across test trials and test sessions, that is, visual-fields are not repeatable [10]. Several previous studies have found the visual-evoked potential (VEP), an objective technique, to be useful in detecting a wide range of visual-field defects [10-15].

Due to its objective nature and short test trial duration, the VEP approach is likely to be more reliable, especially in children and in populations having cognitive deficits [16]. The VEP method attempts to bypass all, or at least minimize, the shortcomings which are present and inherent in conventional perimetry [15].

In a previous study recently completed in our laboratory [15], circular, annular, hemi-field, and quadrant visual-field defects were simulated and assessed objectively using the VEP method. The results were very consistent, and thus encouraging. However, none of the previous studies further studied and tested visual-field defects smaller than quadrants [10-15].

The purpose of the present study was to assess the effect of simulated octant, visual-field defects on the VEP amplitude in a visually-normal adult population.

- Five visually-normal adults comprised of students and faculty at the SUNY college participated in the study.
- They had a mean age of 31.8 years, with a range from 19 to 70 years.
- Each had best corrected visual acuity of 20/20 at distance and near in each eye binocularly and monocularly.
- Conventional full-field VEP testing was employed using the DIOPSYS® MODA-TR system (Diopsys, Inc., Pine Brook, New Jersey [SA]) (17 H x 15 V degrees of visual size, 64x64 check size, 1 meter distance, 64 cd/m², 1 Hz temporal frequency, 85% contrast, binocular viewing with spectacle correction) (Figure 1A).
- To accomplish the octant array, the full-field (17H x 15V degrees) checkerboard pattern was divided into 8 equal parts as represented in Figure 1B. Each was designated as an octant (i.e., 1, 2, 3, 4, 5, 6, 7, and 8). Each octant subtended a visual angle of 8.84H x 3.75V degrees at 1 meter. The two different octant test configurations were:
  1. 1/8th non-patterned octant stimuli – For presenting the 1/8th non-patterned octant stimuli, 1 of the 8 regions of the full-field checkerboard pattern was non-patterned (i.e., blank) luminance of 1.27 cd/㎡, while the other 7 patterned octants were present (64 cd/㎡), as shown in Figure 1C.
  2. 1/8th patterned octant stimuli – For presenting the 1/8th patterned octant stimuli, 1 of the 8 regions of the full-field checkerboard pattern was patterned (i.e., was present), while the other 7 octants were non-patterned or blank as shown in Figure 10. Luminances were as described above in 1.
- Test duration was 80 seconds for each trial to reduce response variability.
- For each subject, testing was distributed over four days to prevent fatigue effects. Total test time for each subject was 4 hours.
- The average of 3 trials for each of the 3 test conditions (i.e., full-field, 1/8th non-patterned octant stimuli, and 1/8th patterned octant stimuli) was used in the analysis. All 3 test conditions were randomized.

METHODS
- Clinical visual-field testing, or perimetry, is a critical and primary technique used to assess for visual-field defects that are present in many clinical patients [1, 2].
- Distinct visual-field defects are commonly found in several retinal diseases, such as glaucoma, retinitis pigmentosa, and age-related macular degeneration [1, 3], as well as in several neurological conditions, e.g., acquired brain injury [4], and these may be small in extent in some cases.
- In addition, there is one type of visual-field defect, referred to as the “swiss cheese defect”, in which “patchy” and irregularly-shaped visual-field areas with variably reduced visual sensitivity are found [5, 6], which may be difficult to detect. This type of defect is common in patients diagnosed with glaucoma [5], cortical visual impairment [7], hypoxic or anoxic brain insult [8], and traumatic brain injury (TBI) [9].
- However, visual-field test findings have been called into question over the past several decades [e.g., 8, 9]. The key criticism is that they exhibit considerable variability across test trials and test sessions, that is, visual-fields are not repeatable [10]. Several previous studies have found the visual-evoked potential (VEP), an objective technique, to be useful in detecting a wide range of visual-field defects [10-15].
- Due to its objective nature and short test trial duration, the VEP approach is likely to be more reliable, especially in children and in populations having cognitive deficits [16].
- The VEP method attempts to bypass all, or at least minimize, the shortcomings which are present and inherent in conventional perimetry [15].
- In a previous study recently completed in our laboratory [15], circular, annular, hemi-field, and quadrant visual-field defects were simulated and assessed objectively using the VEP method. The results were very consistent, and thus encouraging. However, none of the previous studies further studied and tested visual-field defects smaller than quadrants [10-15].

RESULTS
- Figure 2A presents the group mean amplitude for the full-field patterned and the 1/8th non-patterned octant stimulus configurations.
- A repeated-measures, one-way ANOVA for the factor of stimulus configuration was significant (p < 0.05). The post-hoc Tukey test revealed the following significant comparisons as related to the full-field value: 3 and 7.
- Figure 2B presents the group mean amplitude for the full-field patterned and the 1/8th patterned octant stimulus configurations.
- A repeated-measures, one-way ANOVA for the factor of stimulus configuration was significant (p < 0.05). The post-hoc Tukey test revealed the following significant comparisons as related to the full-field value: 1-8.

CONCLUSIONS
- The results provided evidence that the VEP, an objective technique, could be used reliably to detect relatively small simulated scotomas in each subject.
- Both the group and individual subjects revealed that the full-field patterned VEP amplitude were significantly different from each of the isolated 1/8th patterned, simulated, visual-field defects, but not from each of the 1/8th non-patterned octant configurations.
- The optimal test stimulus for accurate amplitude-based assessment and spatial differentiation was the 1/8th patterned octant (Fig. 2).
- This isolated octant paradigm may now be extended to pilot testing in clinical patients manifesting such small and scattered scotomas (e.g., glaucoma, traumatic brain injury). The VEP can now be extended even further and be used as a relatively rapid and simple objective technique to assess small visual-field defects, especially in special populations (e.g., young children and those cognitively impaired), who may be unable to respond reliably to traditional visual-field testing.

REFERENCES
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