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# OBJECTIVE PERIMETRY BY PATTERN SHIFT VISUAL EVOKED RESPONSES

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## Abstract

**A new device for objective perimetry using VERs evoked by the pattern shifter was developed. The amplitude of VERs was the highest at the center of the visual field and it was declined to the periphery like a probability curve. It revealed recognizable VERs from the peripheral visual field of 60° of nasal and 90° of temporal. This method was also evaluated in a case with concentric contraction of visual field and it was found to be equivalent to the snbjective perimetry. These evidences suggest that the kinetic stimuli are more effective than the static stimuli for the objective perimetry, since peripheral visual field is sensitive to a moving target.**

## INTRODUCTION

Pattern shift visual evoked responses (VERs) is induced by the bright and dark checkerboard moving horizontaly at a given amplitude on the screen. This procedure was first described by Regan & Heron[1)] for the objective determination of half-field defect in a case of homonymous hemianopsia.

Applying this procedure to the objective perimetry, it was found that this procedure was capable of sensitive measurements. We now describe about the development of a new device and fundamental conditions of measurements.

On the objective perimetry using VERs, a number of investigations have been reported since Copenhaver[2)] (1963). VERs evoked from the peripheral visual field, however, was too small to be identified and measured by ordinary flicker stimulation. Utilizing scotopic VERs, Iwata[3)] had developed a new technique of the objective measurement to some extent. Maruo[4)] advanced this possibility by using the vertex potential of VERs.

Our method using kinetic visual stimuli revealed an advanced objective visual field determination and it will bring a new knowledge on the kinetic response of peripheral field.

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## MATERIALS AND METHODS

The perimetric device is consisted of the perimeter system and projection system (Figure 1). The perimeter covered with black felt is an arc of 100 cm in diameter and 20 cm in width, and it subtends 200°. A stimulating translucent

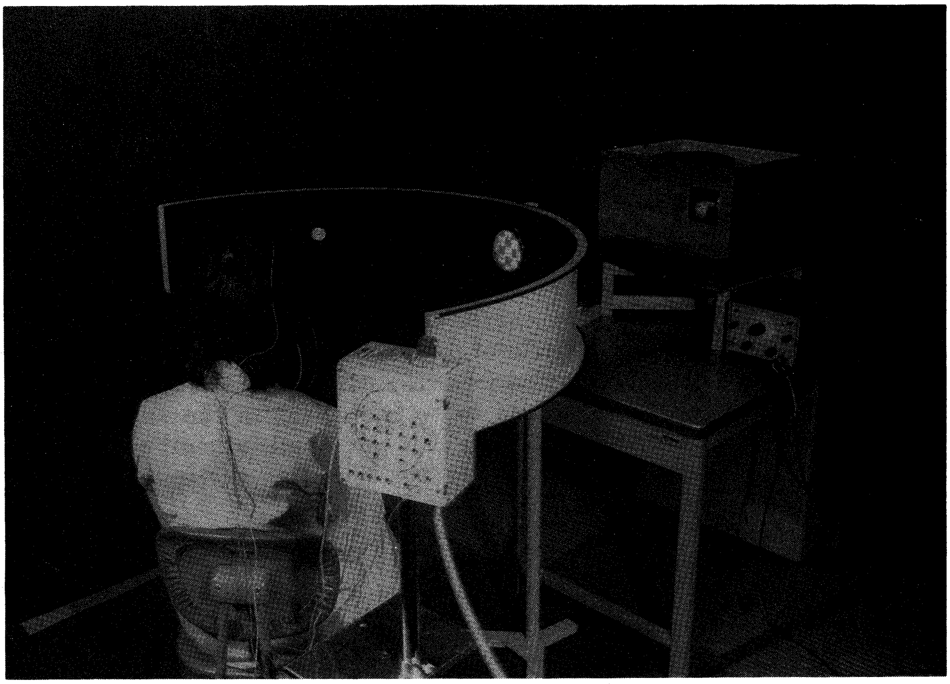

Fig. 1. General view of the pattern shift perimeter.

screen subtended 5° or 10° circle is located at the center and a projection of target is given from behind of the perimeter. Pattern shifter (Biocomputronix, San Diego) is consisted of a slide projector and a galvanometer mirror to make oscillatory movements of the checkerboard. One square of check is 2° of arc with 94% of contrast and 470 cd/m$^2$ of mean luminance. The amplitude of the shift was 2.5 square width usually and the moving form was square wave of 10 Hz frequencies. The subject was seated at the center of the perimeter with a distance of 50 cm keeping an arbitrary direction against the stimulating screen. Thus in a routine examination, stimulating areas of the retina were changed at 0°, 30°, 60° or 90° horizontally.

Ten normal subjects (the members of ophthalmology department) and two patients with concentric contraction of visual field were used with right eyes for the investigation.

Electrodes were placed at 5 cm anterior to the inion for precordial electrode and on ear lobe for indifferent electrode. Using a computer (Saneisokki, Tokyo, SM 01), averages of 200 responses were made on-line, and the VERs recorded on an X–Y recorder.

## RESULTS

1. Condition of stimuli

Using a wave form generator which generates sawtooth wave, square wave, sin wave and triangle wave, stimulus wave form of the pattern shifter was compared to find out the most effective stimulation. Square wave evoked the largest amplitude of VERs from the peripheral field.

Width of the target movement was altered 0.5, 1, 2, and 2.5 square of the check width and amplitude of each VERs was compared at the central visual field and at 30° temporal of the visual field. The VERs amplitude obtained by 2.5 square movement was the largest from the peripheral visual field. The movement of 2.5 square was the maximum width which could be generated by the galvanometer.

Regarding to stimulus frequency, 10 Hz of stimuli evoked the largest VERs at the peripheral visual field compared with 5 Hz and 20 Hz.

Size of the target was also tested. Comparing 5° circle and 10° circle, VERs evoked from the peripheral visual field by 5° circle was declined extensively, therefore 10° circle was applied usually.

2. Change of VERs amplitude due to stimulus location in the visual field.

VERs was evoked at every 30° in the visual field of horizontal meridian (Figure 2). The amplitude was maximum at the center of field ($2.9\mu v \pm 0.56 \mu v$) and it reduced gradually to the peripheral field (Figure 3). Small responses were obtained even at 60° of the nasal or 90° of the temporal fields. The decline of amplitude was more acute in the nasal field than in the temporal field. For example, the amplitude obtained at 30° of the nasal field was somewhat lower than that obtained at 30° of the temporal field.

3. The objective perimetry in a case with concentric contraction of visual field.

A case, a male of 52 years of age, had a visual field narrowing illustrated in Figure 4 after head trauma. The objective perimetry was carried out by the same method. The amplitude showed a very remarkable decline at the paracentral area. The amplitude at 0° was $2.3\mu v$ which was interpreted as normal range but no response was obtained at 15° or more of both sides.

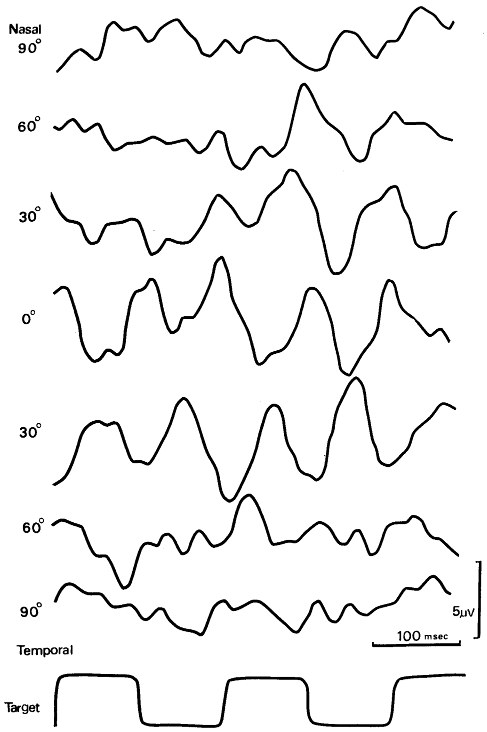


Fig. 2. VERs from different points of horizontal meridian in the visual field. Pattern shift stimulation at 10 Hz. Top ; nasal 90° to bottoms ; temporal 90°. Interval ; 30°

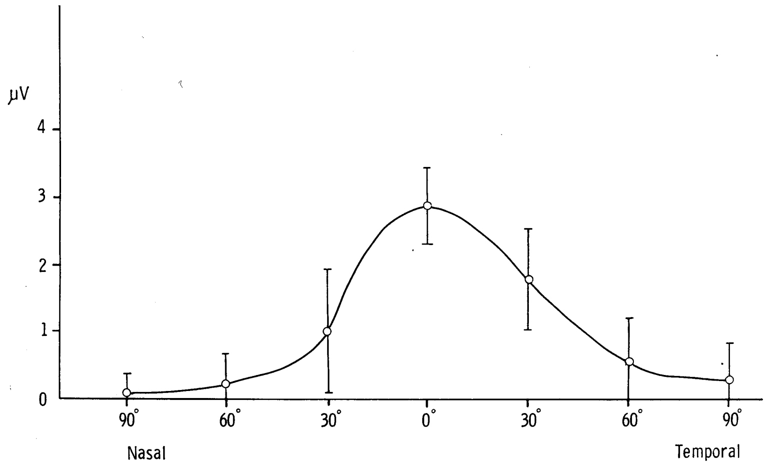


Fig. 3. VERs amplitudes distribution from different points of horizontal meridian in the visual field. Average and SD of 10 normal subjects.

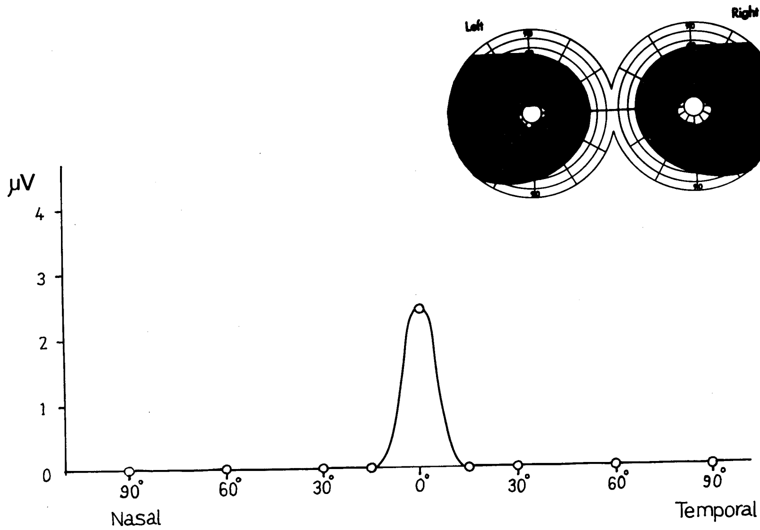


Fig. 4. VERs amplitudes distribution in a case with concentric contraction of the visual field.

## DISCUSSION

Confirmable VERs evoked from the peripheral visual field was revealed by the pattern shift stimulation. Stimulus wave form, moving amplitude, frequency and size of the stimulus field were examined to obtain a most suitable condition. The visual angle of the stimulus field was 5° or 10° and the checks were of 2° side length. Maximum VERs amplitude was evoked by the square wave moving stimuli with 2.5 square width of 10 Hz frequencies. The velocity of the moving stimuli was equivalent to that of 72 km/h, indicating that a strong response was evoked from the visual cortex by stimulating the peripheral visual field with fairly first kinetic stimuli. Square wave movements produced by galvanometer, however, showed flutter in an accurate recording, caused by the inertia of the galvanometer mirror, but it seemed to be negligibile for practical use.

The evidence that VERs was evoked from the peripheral visual field by the kinetic stimuli suggests that peripheral visual field has good cognizance of movements. In this connection, VERs evoked from the peripheral visual field wears off when moving amplitude is narrowed.

These phenomena have scarcely been adapted in VERs recording. On objective perimetry using VERs, a number of investigations have been reported, but our method and principle will bring a new knowledge in physiology of vision. At the present time the short-coming of this method is that the stimulus field subtended 5° and 10° is too large to detect a small defect of the visual field. This may be a limitation of this method, but increasing the additions of the responses seems to make it possible to use a smaller stimulus field.

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