Visual evoked potentials in clinical optometry

Researchers explain procedures, invite referrals

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We can now measure visual acuity in children, including newborn infants, by new methods and instruments. This opens up the whole field of infant (even neonate) visual examinations to optometrists. It will allow us to find visual anomalies before they become manifest and while they can still be prevented from becoming permanent.

Measurement of visual evoked potentials is simple in theory but requires, at present, complicated and expensive equipment that requires specialized training to use. In a few years we should have simpler and less expensive equipment that will be easy for any clinician to use. Visual evoked potentials (VEP) are sometimes referred to as the visual evoked response (VER) or may be simply called evoked potentials (EP).

How it's done

The basic technique requires first attaching electrodes to the scalp and ear. Second, the patient must look in the direction of the generated target (fixation need not be accurate). These potentials from the visual brain are picked up, amplified, and averaged, and a curve of the visual evoked potential is written out on the recorder.

A series of curves is obtained in response to different sizes of checkerboards or grating targets which change form in a predetermined way and rate. When the response to the continuously decreasing target size has nearly disappeared, that target size gives an estimate of the limiting maximum acuity value. Thus, it is possible to record acuity in any person (or indeed, any animal) who cannot communicate for a subjective determination. This technique is of particular value in children less than six months of age where the findings can be used to determine conditions that may induce amblyopia or squint and correct them before they become manifest and embedded.

Another important use of visual evoked potential measurements is in the diagnosis of optic nerve demyelinating diseases such as optic neuritis and multiple sclerosis. Here, it is not the amplitude of the wave that gives the limiting value, but the latency or delay in the wave. In many cases, multiple sclerosis has been clearly diagnosed by the delay of the visual evoked potential. Strangely enough, the delay does not disappear after recovery from the disease, showing permanent damage does occur even though vision has functionally recovered.

Although the visual evoked potential can be used to perform an objective refraction, with current methods the cylindrical value is probably no more accurate than by retinoscopy, manual or automated. Therefore, the VEP is not ordinarily worth performing for refraction alone. In principle the VEP should be superior to any other method of objective refraction, but in practice it is not, at least not yet.

Fig. 1 — Patient age 2 having his acuity measured by visual evoked potential responses (VEP).

Reading the Record

In visual evoked potential work a new notation is used. It is spatial frequency expressed in *cycles per degree* which has equivalent values in Snellen acuity notation or in minutes of arc, both units that are very familiar to optometrists. In a grating, it is expressed as the number of pairs of black and white bars (each pair a cycle) in one arc degree of visual angle. For example, 30 *cycles per degree* is the same as 1 minute of arc detail or 20/20; and three *cycles per degree* correspond to 10 minutes of arc or 20/200. There are important theoretical reasons for using this notation and in time it will become as common in clinical optometry and ophthalmology as it is in visual science.

Fig. 1 shows a young patient having his visual acuity measured. Figs. 2a and 2b show a series of evoked potential curves indicating the acuity in a 12-year-old girl with suspected hysterical amblyopia (best subjective corrective acuity 20/60 OD and OS). The stimuli were black and white gratings that were briefly presented and then replaced by a diffuse field of the same average luminance (called onset-offset) giving the curves in Fig. 2a. In Fig. 2b, the amplitude of the large positive (upward) component (measured from the record baseline) is plotted against the spatial frequency and Snellen equivalent of the gratings.

One method for determining the VEP acuity is by bracketing the curves in Fig. 2a. For example, the right eye acuity lies between the 20/26 response, where a pattern VEP is still clearly distinguishable, and 20/18, where a pattern VEP is no longer visible.

Alternatively, "threshold acuity" is derivable from data trends as in Fig. 2b. A line is drawn through the data points and the VEP amplitude extrapolated to zero potential or the X-axis intercept. This method yields threshold acuities of about 20/20 OD and 20/30 OS for this patient. In addition to these acuities, the large responses obtained when the patient said she could no longer see the patterns (arrows in Fig. 2a) confirm the tentative diagnosis of hysterical amblyopia which was made after a thorough neurological examination.

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The School of Optometry solicits your referrals for visual evoked measurements on your patients. High equipment costs necessitate a fee of $100 which qualifies for third-party payment, and may be reduced or remitted in cases of financial hardship. Please refer to the appointment secretary, Darlene Bagsby, at (415) 642-5726 or (415) 642-5761 for appointments or write to the Visual Evoked Potential Clinic, School of Optometry, University of California, Berkeley, California, 94720.

Within the next few years it is expected that visual evoked potential equipment will become available that will cost perhaps half of the current $20,000 and will be largely automated so that it can be readily and economically used by almost any clinician in almost any practice. In the meantime, we solicit your referrals and will be glad to explain all findings in detail so that you may become more familiar with this new advance in visual science and optometry.

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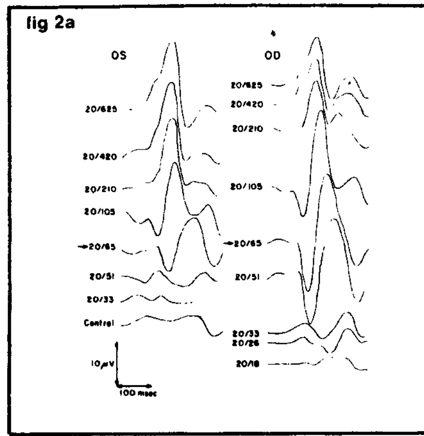
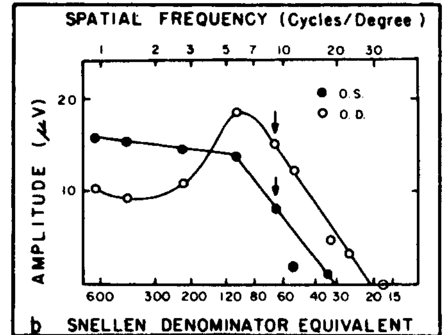


Fig. 2 — Evoked potentials from a 12 year old girl suspected of hysterical amblyopia.

a. — Arrow shows subjective acuities are 20/65. VEP acuities are seen as between 20/26 and 20/18 OD and greater than 20/33 OS. For further explanation see text.

b. — Graphed presentation of VEP data from Fig. 2a. Arrows show subjective acuities. Baseline (at zero V) for the curves shows objective VEP acuities of OD 20/20 and OS 20/30.



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