Mueller matrices. The PMAP program takes ray-trace data as input and uses the Fresnel equations to calculate a Mueller matrix to describe the optical system's polarization effects on any ray. For a grid of rays, the Mueller matrices for each ray are combined to form an image Mueller matrix between any object and its image point. This image-point Mueller matrix contains intensity information, polarization couplings, and the polarization of the image for any object polarization state. The variation of polarization parameters in the exit pupil is also calculated. This provides a polarization aberration description of the light to augment the geometrical aberration information provided by ray tracing.

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WK25. Spectrographic Identification of Visual-Evoked-Response Components. ANTHONY M. NORCIA, *Smith-Kettlewell Institute of Visual Sciences, Medical Research Institute of San Francisco, 2232 Webster Street, San Francisco, California 94115.*—A set of evoked-response components has been isolated through short-time spectrum analysis of the response generated by the appearance of sine-wave luminance gratings ranging in spatial frequency from 0.5 to 8.0 cycles/deg. Fourier analysis of the response wave form indicates that spectral power is concentrated in narrow bands or formants that differ in frequency from the spontaneous EEG. The first two formants are found below 12 Hz and are differentially selective for spatial frequency. The first formant at approximately 4 Hz is dominant at spatial frequencies below 2 cycles/deg, while the second formant at approximately 8 Hz is largest at 4 and 8 cycles/deg. The time evolution of the evoked response formants was studied by successive calculation of the spectrum over a running analysis window. Smooth estimates of the evoked-response spectrum as a function of time were calculated by linear predictive coding. The second formant was found to emerge earlier in time than the first formant, with both formants shifting frequency over the time course of the response. Single evoked responses are measurable using the linear predictive coding spectrum model.

WK26. Broca–Sulzer Visual Evoked Potentials: Brightness- and Darkness-Enhancement Versions. NAOYUKI OSAKA, *Department of Psychology, Otemon-Gakuin University, Ibaraki, Osaka 567, Japan.*—The flash duration producing maximal brightness enhancement, i.e., the Broca–Sulzer effect (BSE) was obtained from six observers at several flash intensity levels (between 1.2 and 3.2 log Td) with 11 flash durations (between 1 and 2000 msec). Similarly, the duration producing maximal darkness enhancement, i.e., darkness version of the BSE, was obtained.[1] A 1-deg test target was presented on 6-deg background as the increment/decrement flash for brightness/darkness enhancement, respectively. Although, the BS duration decreased as a function of increasing intensity, the major brightness/darkness peak of the BSE was observed for flash durations between 200 and 30 msec.[2] Because of the BSE, the N1–P2 amplitude of the visual evoked potential (VEP) from *Oz* position was found to be highly correlated with perceived brightness/darkness enhancement. With the flash durations longer than 500 msec the VEP amplitude remained constant, but with the flash durations shorter than BS duration VEP amplitude tended to decrease as flash duration decreased. The BS duration generated significantly larger amplitude than either shorter or longer flash both for brightness and darkness versions. The findings are discussed in the light of an opponent-response model.

[1] R. A. Björklund and S. Magnussen, Vision Res. **19**, 155 (1979).
[2] N. Osaka, J. Opt. Soc. Am. 72, 62 (1982).

WK27. Evoked Potential Contrast Sensitivity as a Function of Luminance. MARK W. CANNON, JR., *Aviation Vision Laboratory, AFAMRL/HEA, Wright-Patterson Air Force Base, Ohio 45433.*—Both visual evoked potential (VEP) and psychophysical contrast sensitivity functions (CSF's) for sine-wave gratings were obtained from five subjects over a spatial frequency range of 0.5 to 16 cycles per degree at four different luminance levels: 100, 10, 1, and 0.1 cd/m^2. The stimuli for both VEP and psychophysical experiments were counterphase flickered at 13.5 reversals per second. While individual VEP CSF's show more variability than psychophysical CSF's, mean VEP and mean psychophysical CSFs show excellent agreement. In fact, relative amplitude changes in mean VEP and psychophysical CSF's are almost identical as luminance is reduced. Estimates of VEP grating acuity were made at each luminance level by extrapolating the high-spatial-frequency side of the VEP CSF to a contrast sensitivity of 1 on a plot of log contrast sensitivity versus linear spatial frequency. The spatial frequency at which this extrapolation reaches contrast sensitivity of 1 is the VEP grating acuity. A plot of VEP grating acuity versus luminance has the same shape as a plot of psychophysical grating acuity versus luminance determined for the same luminance range but is about a factor of 1.5 to 1.6 lower. These data demonstrate, for the first time known, a direct simultaneous correspondence in shape, amplitude, and grating acuity between psychophysical and VEP CSF's over a 3-log-unit range of luminance.

WK28. Adaptation, Color of the Stimuli, and Human Electroretinogram. HIROKO YAMAZAKI AND JOHN C. ARMINGTON,* *Department of Ophthalmology, Chiba University School of Medicine, 1-8-1 Inohana, Chiba, Japan 280.*—The subjects viewed temporally alternating black–white or colored checkerboard patterns while their electroretinograms were recorded. The spatial frequency of the pattern was varied. The temporal alternation rate of black–white stimuli was 0.1 Hz, and the phase was not symmetrical so that every other square of the retina, where the brighter checks stayed longer, was more light adapted than ones in between. Symmetrical 1-Hz temporal rate was used for the colored stimuli. Regardless of the stimuli, the amplitude of both the b wave and the afterpotential increased with decreasing spatial frequency, but the extent of the effect depended on the stimulus conditions. The amplitude of the afterpotential to the shorter phase of alternation of black–white stimuli was larger than that to the longer. Also, slow plateaulike potentials following the afterpotential showed different wave forms according to the duration of the phase. Larger responses were seen with low-intensity blue than with low-intensity red stimulation when coarse stimuli were used. The results may be interpreted, in part, in terms of differing participation of rod and cone mechanism in the electroretinogram to pattern stimulation.

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WK29. Grating-Evoked Cortical Potentials and Perceived Contrast. HANS STRASBURGER, WOLFGANG SCHEIDLER, AND INGO RENTSCHLER, *Institute for Medical Psychology University of Munich, Schillerstrasse 42, 8000 München 2, Federal Republic of Germany.*—Unlike subjective perception of contrast, steady-state evoked cortical potentials (VEP's) elicited with counterphased gratings may vary abruptly with changes in spatial frequency.[1] To avoid possible artifacts we developed a digital fast-sweep technique for investigating this discrepancy. In most of our 13 subjects, at high stimulus contrasts the dependency of VEP amplitude on spatial frequency had two pronounced peaks separated by a sharp notch at around 3 cycles per degree. With decreasing contrast these variations leveled out, and a unimodal response function was obtained at low contrast. A linear relationship between log contrast and VEP amplitude[2] was found for any given spatial frequency only in the low-contrast range. With increasing contrast the VEP amplitude saturated at a rate that depended clearly on spatial frequency, with a nonmonotonous dependency occurring at intermediate spatial frequencies. The latter phenomenon of oversaturation apparently gave rise to the above-mentioned bimodal response characteristic. Results of a careful analysis of VEP phase lags are added.

[1] C. W. Tyler *et al.*, Brain Res. **33**, 535 (1978).
[2] F. W. Campbell and L. Maffei, J. Physiol. **207**, 635 (1970).

WK30. Simulation of Reversal Time Distributions in Binocular Rivalry. SIDNEY R. LEHKY, *Department of Biophysics and Theoretical Biology, University of Chicago, 920 East 58th Street, Chicago,*