Scotopic Luminosity Curve as Obtained by the Visual Evoked Response in Man

The visually evoked response (VER) in man is often attributed to the photopic system, either on the evidence of spectral sensitivity curves measured from latency or amplitude data[1–3] or from the lack of VER features evoked only under scotopic conditions[4,5].

Visual evoked responses have been recorded to a 10° large test light projected on the center of the retina in Maxwellian view at luminances ranging from 0.5 to 2 log units above the sensory threshold of a dark adapted subject. The effect of stimulus luminance on the latency of VER is shown in Figure 1. Latency versus luminance plots have a common slope over the spectrum, the latencies of the VER recorded under scotopic conditions are longer (more than 200 msec) than the latency of the VER recorded during light adaptation (Figure 1). An increase of test light luminance results in a decrease of the latency of the selected peaks of the VER. This reduction is more marked under dark than under light adaptation. With a criterion latency as a constant response, spectral sensitivity curves have been calculated in the dark adapted state (criterion latency = 210 msec) and during light adaptation (criterion latency = 175 msec). The colored lights were produced with interference band filters (SCHOTT, Type AL, bandwidth 20 nm, transmission peaks between 400 and 630 nm) and calibrated in respect to energy output. The VER sensitivity curve measured in the dark adapted state fits the scotopic luminosity curve (Figure 2, dots). The VER sensitivity curve measured from records during light adaptation with two different criterion latencies (175 and 168 msec) fits the photopic luminosity curve (Figure 2, open symbols), thereby demonstrating a Purkinje shift in the VER. Scotopic VER recorded with Ganzfeld methods have been attributed to rods located in the periphery of the retina[6]. However, a 10° spot of light projected onto the periphery of the retina at a luminance of 1.5 log units above the absolute threshold failed to elicit a VER; if the same spot of light is projected onto the central retina it will – even if it is seen dimmer – result in a clearly defined VER. Our conclusion is that the VER is not primarily photopic or scotopic but is preferentially sensitive to stimuli received on the central parts of the retina. A similar conclusion has been drawn by VAN LITH and HENKES[7] as they studied the correlation between the amplitude of the VER and the number of cone stimulated. Furthermore, in the present study we measured the recovery of the scotopic VER during dark adaptation. A VER can be recorded to a green light at a luminance of 1.5 log units above the absolute threshold after 10 min of dark adaptation. Following a 3 min white bleach of 10^4 Td, the VER

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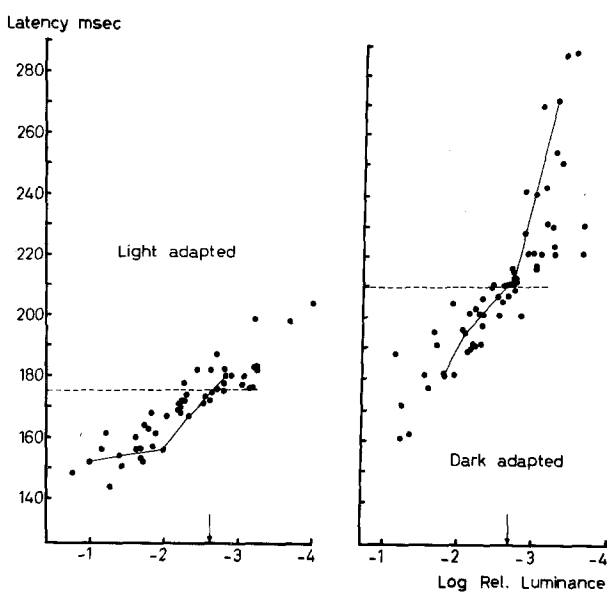

Fig. 1. Effect of luminance on the latency of the VER. The ordinate is the time interval between the onset of the light pulse and a selected peak of the VER. Light pulse duration is 100 msec under dark adaptation, 20 msec under light adaptation (10^3 Td, 15°). The latency versus luminance plots recorded with different test light wavelengths have been shifted together along the luminance axis (logarithmic scale) to show the common slope of the plots. The effect of luminance on latency is greater under dark adaptation. The relative luminances range from 0.5 to 2 log units above the subjective thershold of the subject in the actual recording conditions. The horizontal dashed lines are the latencies which have been chosen as criterion responses.

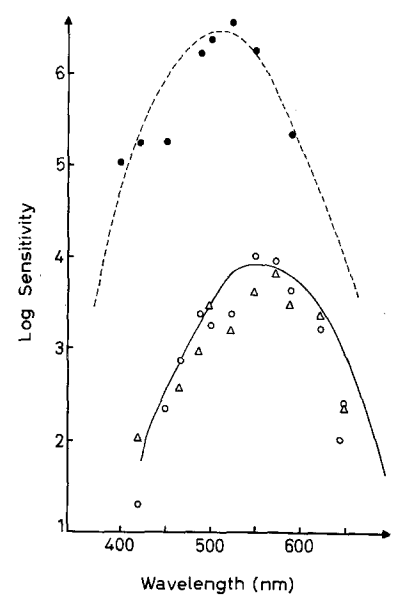

Fig. 2. Action spectra of the VER. The ordinate is the reciprocal value of the energy needed to reach a criterion latency. The abscissa is the wavelength of the lights. The dark dots are obtained under dark adaptation with a criterion latency of 210 msec. The scotopic luminosity curve has been drawn through the points. The open circles are data from the same subject under light adaptation (10^3 Td, 15°) with a criterion latency of 175 msec. The open triangles are data from another subject with a different criterion latency (168 msec). The triangles have been shifted upwards to match the open circles. The photopic luminosity curve has been drawn through the points.

grows in amplitude from the 10th to the 18th min of dark adaptation. Therefore, the time course of the increase of the VER in the dark is similar to that of scotopic vision.

Zusammenfassung. Eine visuell evozierte Antwort kann durch Stimulation der zentralen retinalen Anteile mit skotopischen Reizen nach Dunkeladaptation aufgenommen werden. Die spektrale Empfindlichkeit wurde für eine konstante Antwort (Latenz = 210 msec) gemessen und stimmt mit der dunkeladaptierten Empfindlichkeit des menschlichen Auges in der spektralen Verteilung überein. Der zeitliche Verlauf der Amplitudenzunahme des VERs während der Dunkeladaptation ist der sensorischen Empfindlichkeit ähnlich. Das VER ist eine Antwort der zentralen retinalen Anteile, kann aber neben photopischen auch Eigenschaften des skotopischen Systems aufweisen.

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Sleep in the Giant South American Armadillo *Priodontes giganteus* (Edentata, Mammalia)

Knowledge of the biological role of sleep remains obscure despite intensive research. Very few of the existing hypothesis about it have been derived on the basis of evolutionary deduction. One of the reasons of this situation is that existing knowledge is still very scarce in spite of the considerable number of reports from different species of mammals. We think that any new report on the characteristics of the sleep patterns of mammals has special importance, because often the most crucial clues about the survival value of a function come from data about in which species it is present. We also think that the possibility of finding variations in the above-mentioned patterns must always be kept in mind. These eventual variations could lead to new discoveries. This report makes a contribution to the comparative physiology of sleep, with a lower eutherian mammal, the giant South American armadillo *Priodontes giganteus*. This is the world's largest surviving species of armadillo. It is hardly captured because of its rarity. The danger of extinction is not negligible. The last two facts, together with the philogenetic position of the order Edentata, increases the intrinsic interest of the study of its sleep characteristics. The observations were made in the only two specimens that we could obtain after long searchings.

Method. The animals weighed 46 and 50 kg, respectively. They were chronically implanted with bipolar electrodes, fixed on the surface of the armour that covers the cranium. The EKG was taken by means of 2 silver discs also chronically implanted over the chest. The EMG of the muscles of the neck and of the flexor digitorum of the hind limb was studied by means of bipolar concentric electrodes deeply inserted into the muscles.

The animals were placed in a Faraday cage, and left free and unanesthetized. They were studied at 2 different environmental temperatures: below 28 °C (between 23° and 28 °C) and above 28 °C (between 28° and 33 °C). The experimental animals were left at least 30 min exposed to those temperatures, before the beginning of the electrical recordings. The temperature of 28 °C was critical in relation to the appearance of tremor during the phase of slow sleep. The observation of the animal's behaviour was prolonged over a period of 96 h, in order to find its bioelectrical correlates.

Results. The electrical activity recorded from neocortex showed the following features: A) during wakefulness. The EEG showed low voltage, fast and irregular activity (Figure 1, A). The EMG of the neck muscles revealed varying degrees of activity with the movements of the neck. The EMG of the flexor muscles of the hind limb always showed powerful bursts with walking move-

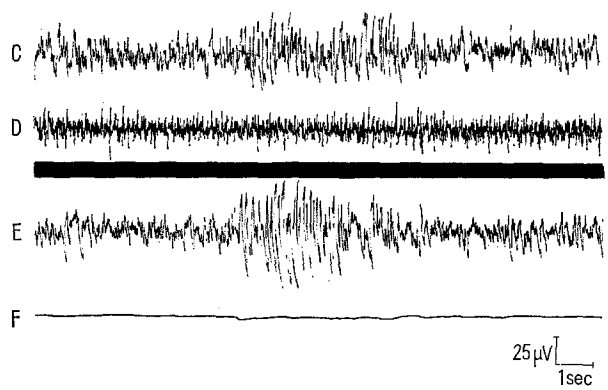

Fig. 2. Slow sleep. C) EEG below 28 °C. D) EMG of limb muscles below 28 °C. E) EEG above 28 °C. F) EMG of limb muscles.

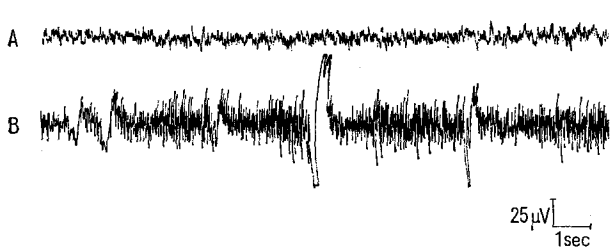

Fig. 1. Wakefulness. A) Neocortex. B) EMG of limb muscles.

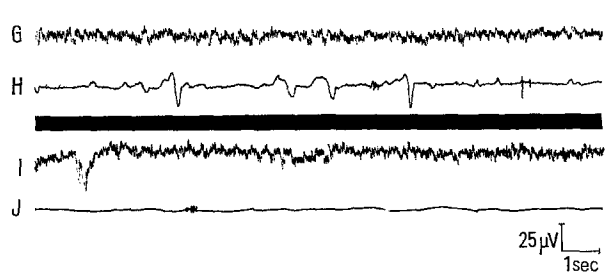

Fig. 3. R.E.M. sleep. G) EEG below 28 °C. H) EMG of limb muscles below 28 °C. I) EEG above 28 °C. J) EMG of limb muscles below 28 °C.