tradian rhythm but assume that there is a central neural mediator because of the striking synchrony of this fast-frequency rhythm across animals; the rhythms may stem from the light-dark circadian cycle, since the 90-minute period is a harmonic of 24 hours. In prior work monitoring the clearance of [^{14}C]cortisol from peripheral blood in this animal model, we demonstrated that rapid changes in distribution, binding, and metabolism were not important factors in generating this rhythm (*5*). We now add findings which argue against the classic concept (*11*) that the adrenal cortex is integrally and inseparably linked to immediately preceding hormonal events occurring in the hypothalamo-pituitary axis.

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Alpha Blocking: Absence in Visuobehavioral Deprivation

Abstract. *Subjects with congenital deficits that allowed only diffuse light perception through one eye were examined for blocking of the alpha rhythm. With only the deprived eye open the electroencephalogram is dominated by alpha rhythm that is not blocked by photic stimulation, even though the stimuli evoke a response from occipital cortex.*

In his pioneering work on cerebral electrical potentials, Berger (*1*) described the alpha rhythm of the electroencephalogram (EEG). Alpha rhythm was one of the first EEG parameters to be linked with behavioral states. Its presence is associated with a meditative, quiescent state whereas its absence (cortical desynchronization) is associated with focused attention and arousal (*2*).

Blocking of the alpha rhythm by photic stimulation is useful both clinically and in the research laboratory (*3*). Alpha blocking can occur under two conditions. If a person is resting quietly with his eyes closed and is producing alpha waves, if he opens his eyes the alpha rhythm will be blocked and EEG desynchrony will be induced; or, if a person is relaxed with the eyes open and generating alpha rhythm, a flash of light will similarly block the alpha rhythm.

The exact nature of the alpha blocking process is not known. Alpha blocking may result from activation of the geniculostriate pathway alone. On the other hand, for blocking to occur perhaps this afferent volley must not only excite primary visual mechanisms but also engage the arousal and attentional processes of the brain which depend upon extrasensory neural pathways. These two explanations for alpha blocking may be studied in individuals born with a deficit of one eye that allows only diffuse light perception. The lack of form perception in these persons limits the use of the deprived eye for behavior; such persons rely on the "good" eye for visual function.

In such individuals the diffuse input from the deprived eye presumably maintains the retinocortical pathways so that stimulation of the deprived eye will evoke a response from the occipital cortex (*4*). However, if a subject grows up seeing only diffuse light, the activation of the nonspecific pathways of the brain (*5, 6*) responsible for the generation of cortical desynchronization (*7*) is disrupted. I now report that photic stimulation of the deprived eye does not block the alpha rhythm, even though it evokes a response from the occiptal cortex.

The data for this study were collected from three human subjects (*8*). Subject A is a 19-year-old female. She had a congenital cataract of the right eye which was removed 7 months before the testing. Prior to the cataract removal she could count fingers at a distance of 7.5 cm; at the time of testing she could count fingers at a distance of 2.5 m. Her left eye is normal. Subject B is a 5-year-old boy with whitish cellular debris located centrally in the anterior vitreous of the left eye due to birth trauma. Only light perception is possible with his left eye; his right eye is normal. Subject C is a 20-year-old male with a congenital cataract of the right eye. His deficit is uniform throughout the visual field and allows him to detect hand movements. His left eye is normal with a corrective lens. The three subjects stated that they did not use their "bad" eye for vision nor could they ever recall doing so.

The EEG was recorded from the subjects with an electrode placed on the scalp contralateral to the deprived eye and 1 cm lateral to the midline over the occipital protuberance of the skull. The reference electrode was placed on the ear ipsilateral to the recording electrode. The subjects lay on a bed and looked up at a stimulus panel (milk-white plexiglass covering 35° of visual angle) illuminated from behind by a Grass photic stimulator at a rate approximating one flash every 5 seconds. The EEG was recorded with a Grass polygraph (low-frequency cutoff, 1 hertz; high-frequency cutoff, 70 hertz) and stored on magnetic tape. With one eye patched, a series of stimuli were presented until 50 artifact-free responses were accumulated. The evoked response

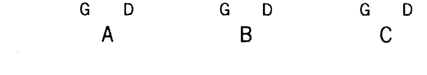

Fig. 1. Histogram showing the percentage of the EEG recording time that consisted of alpha rhythm, for the three subjects, A, B, and C with either the G (good) or D (deprived) eye open.

was computed with a signal averager (TMC CAT 400C) and plotted with a strip chart recorder. The amplitude of the response was measured as the distance between the initial positive and negative peaks of the response.

The total recording time in minutes for each subject with only the G (good) and D (deprived) eye open was: subject A, G = 8.4, D = 6.3; subject B, G = 7.2, D = 6.0; and subject C, G = 8.0, D = 8.5. The EEG was scored (*9*) for presence of alpha rhythm by underlining those sections of the record which showed alpha, measuring the underlining in millimeters, and converting this to a percentage of the entire recording period. Figure 1 shows the percentage of recording time that each subject exhibited alpha rhythm with the deprived eye open and with the good eye open. With only the deprived eye open the EEG is dominated by alpha rhythm in comparison to the amount of alpha present with only the good eye open. To ensure attentiveness to the stimulus the experimenter would remind the subject to keep his eye open and look up at the stimulus panel. Verbal reports of the subject and the experimenter's observations confirmed that the subject had the appropriate eye open during testing. This verbal stimulation may have contributed to the low percentage of alpha rhythm during the good eye trials. The large amount of alpha rhythm generated during the deprived eye trials is even more surprising in view of this auditory stimulation.

Figure 2 presents the visually evoked responses and samples of the EEG's recorded during photic stimulation of the three subjects. The EEG for the good eye condition was selected to show periods of alpha activity. Because of the very low percentage of time that the alpha rhythm was present with the good eye open, these segments are not typical of the recordings which were dominated by low-voltage fast activity. With the good eye open the EEG of subject A shows alpha spindles, none of which occur immediately after exposure to the light stimuli. With the deprived eye open, the EEG is dominated by the alpha rhythm. Even though photic stimulation occurs during the production of alpha, the EEG does not change to the arousal pattern. The occipital response evoked from the deprived eye is similar in waveform to the response evoked from the good eye, but is reduced in amplitude by 53 percent.

The EEG of subject B shows almost continuous alpha rhythm with the deprived eye open, although such rhythm is virtually absent when the good eye is open. The light does not block the alpha that appears with the deprived eye open. The evoked response from subject B is only 4 percent smaller when evoked from the deprived eye than when evoked from the good eye.

With the deprived eye open the EEG of subject C is one series of long-duration alpha spindles, as shown in Fig. 2. The occurrence of the light stimuli during the spindle does not alter its form. When the good eye is open only sparse alpha spindles are present; spindles are never present immediately after a light flash. When evoked from the deprived eye the response from subject C was actually 20 percent larger than when evoked from the good eye.

The results from the three subjects show that when viewing the world with only their deprived eye, alpha rhythm dominates the EEG. A flash of light rarely blocks the alpha rhythm, even though an evoked response is clearly evident from the visual cortex. Thus, activation of neural activity in the visual cortex does not lead to a blocking of the alpha rhythm.

Although a response was recorded from the visual cortex of the subjects in this study, visual deprivation caused by the subject's growing up with the ability to see only diffuse light through one eye does not leave the visual pathways unaltered. In animals, such deprivation produces irreversible deficits in the stimulus specificity of certain neurons within visual cortex (*10*). However, in the deprived cat diffuse light will indeed activate neurons within the visual cortex (*4*). The animal studies also show that after the deprivation the animals are initially behaviorally blind but during a subsequent period of normal visual experience the animals learn to use visual cues in the control of their behavior (*10*). In addition to the abnormalities in visual cortex, work in cats and humans shows that the visually evoked response recorded from nonspecific cortex is also significantly altered in subjects reared with one eye able to see only diffuse light (*5, 6*). In contrast to the permanent deficit in the response from the visual cortex, the response from nonspecific cortex undergoes further changes in correspondence with the postdeprivation behavioral recovery (*5, 6*).

The results of those experiments suggest that visual deprivation has at least two, separable effects upon the central nervous system. The first is the permanent alteration of the primary visual pathways (*10*). In correspondence with

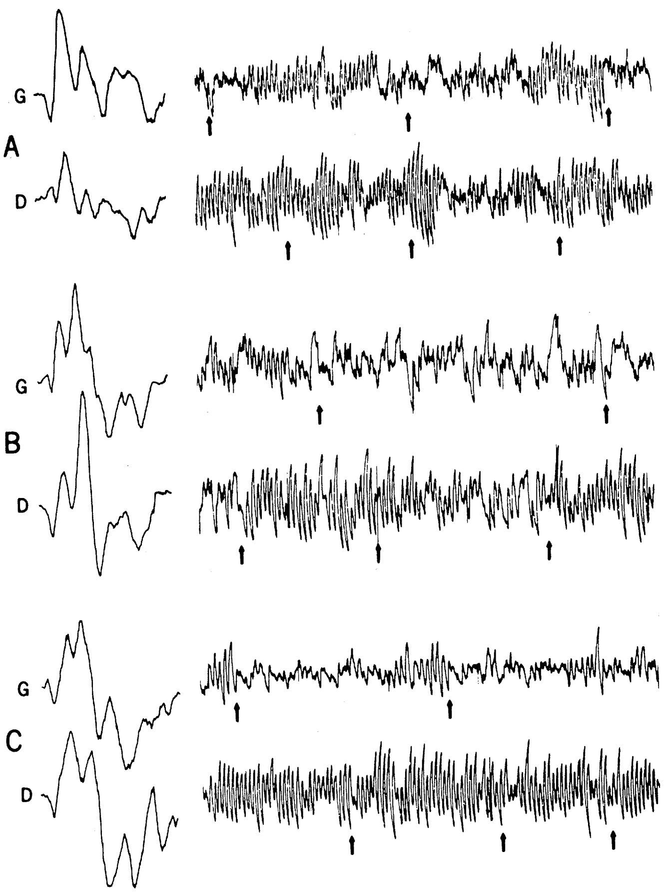

Fig. 2. The visually evoked responses are the sums of 50 responses evoked by stimulation of the G and D eyes of the three subjects, A, B, and C. The stimulus occurs at the start of the trace. Responses recorded with negativity up, and the calibration is 2 μv and 100 msec. The EEG's are from the same subjects recorded with either G eye or D eye open with flash occurring at arrow. Recorded with negativity up; the calibration is 50 μv and 2 seconds.

these neurophysiological findings is the behavioral loss of acuity and pattern discrimination (*10*). Second, the deprivation also affects the nonspecific pathways of the brain (*5, 6*). It may be that changes in these pathways disrupt the animal's ability to use the visual stimulation for the control of its behavior (*5, 6*). In the present experiment, the loss of alpha blocking indicates that the deprivation has severed the functional connection between the primary visual pathways and those pathways of the nervous system, presumably nonspecific, that integrate the visual input with the attentional and arousal mechanisms of the brain.

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Mental Set Alters Visibility of Moving Targets

Abstract. *An observer's knowledge of a moving target's direction and velocity enhances detectability. In addition, knowledge of direction and velocity speeds an observer's reaction to the motion of a previously stationary target. Since rival, nonperceptual hypotheses can be ruled out, these effects represent a direct modulation of vision by mental set.*

Well-controlled experiments have established that a sound will be easier to hear if beforehand the listener can be certain what sound to expect and when to expect it (*1*). Everyday experience suggests similar influences of expectation on seeing, but attempts to demonstrate these effects rigorously have produced equivocal results (*2*). Now, using an objective psychophysical procedure we find that moving targets are easier to see if the observer knows what speed and direction to expect. Since alternative, nonperceptual explanations of this result can be ruled out, we are forced to conclude that mental set can affect even this basic perceptual function.

Our stimuli were random dot patterns presented on a cathode-ray tube (CRT) by a small computer (*3*). Viewing was binocular from a distance of 57 cm. When the dots were of sufficiently high luminance, an observer saw a sheet of about 500 scattered, bright dots moving at 4° per second along parallel paths within a circular aperture (9° diameter). In our first observations an objective psychophysical method, two-alternative forced-choice, was used (*4*). Every trial was divided into two intervals, each 600 msec long, separated by 1 second. During one of the intervals, dots moving steadily at 4° per second were presented; at all other times, including the other interval, the CRT screen was blank. The observer's task was to identify the interval that contained moving dots. A random number algorithm determined the interval, first or second, which would contain dots and which would be blank. A high-pitched tone, coextensive with each interval, defined the intervals for the observer.

In one condition, "stimulus-certainty," the dots' motion was always upward, and the observer could be certain about the direction to look for. In a second condition, "stimulus-uncertainty," the dots' direction of motion was unpredictable from one trial to the next. On half of the trials, the dots moved upward and on half they moved rightward; the two types of trials were mixed randomly. As before, the observer had only to identify the interval that contained the moving dots; no judgment about their direction was required. Fifty-trial blocks of "stimulus-certainty" and "stimulus-uncertainty" were run in alternation, with the subject being informed before each block of the condition to follow. This alternation ensured that any systematic long-term effects (such as fatigue) would affect certainty and uncertainty trials to the same degree. To optimize the observer's performance (*5*), feedback was provided after each correct response, in the form of an auditory signal.

Before collecting actual data from any observer, we found the luminance of dots which would produce about 75 percent correct performance under "stimulus-certainty." That luminance then was used for all subsequent trials. Complete data (300 trials per condition) were collected with two observers. Under "stimulus-certainty," the observations were 77 and 74 percent correct, but under "stimulus-uncertainty," with the same luminance, the observations were only 56 and 53 percent correct—nearly chance (50 percent) performance (*6*). Two supplementary observers, tested with fewer trials, gave similar results: 84 and 75 percent correct with "certainty" and 65 and 52 percent correct with "uncertainty." For all four observers, there was a wide separation between the 95 percent confidence intervals around the means for "stimulus-certainty" and "stimulus-uncertainty." Finally, there was no systematic difference between performance on the two types of uncertainty trials: those on which the dots moved upward and those on which the dots moved rightward. This can be seen in Fig. 1 where one observer's data are given for each of six 50-trial blocks.

The mathematical theory of the ideal detector states that the loss of visibility will be greatest when the two possible, alternative directions are detected by orthogonal (independent) mechanisms (*7*). If each motion mechanism were extremely narrowly tuned for direction, even directions which differed by far less than 90° would have to be processed by orthogonal mechanisms. But if motion mechanisms were very broadly tuned for direction, directions could differ by far more than 90° and still be detected by nonorthogonal mechanisms. As a result, we can use the effects of uncertainty to measure the directional selectivity of motion mechanisms. Suppose we measure the visibility of upward motion when, on any trial, the observer must watch for either upward or some alternative direction. The decline in visibility as the alternative direction departs from upward defines the sensitivity profile (direction tuning) of the upward mechanisms.

Since our two-interval forced-choice results were detection measures, they may be of only marginal relevance to everyday situations outside the laboratory. Consequently, we wanted to make measurements of uncertainty's effect with easily seen, suprathreshold stimuli; this required a different psychophysical procedure. To accomplish this we used reaction time as an index of the motion's visibility at suprathreshold levels; simi-