The mechanism by which transmission through the dentate gyrus is controlled may be inferred from the stimulus-response relationship for the ESP, shown in Fig. 1, B3 and C3. The synaptic current, in contrast to the action current, is greater during the alert state than it is during SWS and REM. This suggests that the granule cells receive tonic inhibitory influences during the alert state which do not operate during SWS and REM, or tonic excitatory influences during SWS and REM which do not operate during the alert state, or both. In either case, the cell membranes are relatively hyperpolarized during the alert state and are relatively depolarized during SWS and REM, with the consequence that an afferent volley of constant size will evoke a larger synaptic current during the alert state, but will be less effective in evoking action potentials in the granule cells.

Deadwyler *et al.* (*11*) reported the existence of a physiological pathway projecting back from the CA_3 zone of the hippocampal formation to the ipsilateral entorhinal cortex. Figure 1, A4, shows a record from the entorhinal cortex in response to stimulation of the angular bundle that is similar to the response previously found to direct stimulation of CA_3, except that the late negative potential is about 3 msec greater in latency in the present experiment. This response presumably represents the same process of entorhinal cortex activation via CA_3 (*11*). The magnitude of this ESP was also found to vary according to the animal's behavioral state, as shown in Fig. 1, B4 and C4. The difference in the ESP between SWS and the alert state seen in the entorhinal cortex is similar to that which has already been shown to occur in the EAP's both in the dentate gyrus and in CA_1. During REM, the response in the entorhinal cortex is large, just as during SWS. This is what occurs also in the dentate gyrus, but is in contrast to what happens in CA_1 where the response during REM is small. This suggests that the relative ineffectiveness of transmission from perforant pathway to CA_1 that occurs during REM is due to some process that acts at the CA_1 level and not at CA_3.

We have shown that at various synapses in the hippocampal formation the effectiveness of neuronal transmission is greater during some behavioral states than during others. This behavioral influence may be conceptualized as a gating process which operates at several critical hippocampal junctures. In the dentate gyrus the mechanism by which gating is effected appears to be either an excitatory influence which is tonically active during SWS and REM or an inhibitory influence which is tonically active during the alert state (*12*). Our findings do not distinguish which of these two mechanisms occurs. However, a substrate for an inhibitory mechanism may be provided by other findings. There are extensive noradrenergic and serotonergic terminations in the dentate gyrus (*4*). These transmitters are known to produce inhibition of neuronal firing rates in the hippocampus, and their neurons of origin fire more rapidly during the alert state than during SWS (*4*, *5*). These findings, taken together, are compatible with the inhibitory mechanism of behavioral gating. However, further experiments are necessary to resolve this point.

The behaviorally specific gating that we have shown to occur in the hippocampal formation controls the passage of information both into the hippocampal formation and from it to extra-hippocampal structures. This gating apparently underlies central nervous system processes that occur during waking behavior, SWS, and REM.

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13. Supported in the main by a grant from the Harry F. Guggenheim Foundation and in part by NIH grant NS 12736. J.W. holds an Alfred P. Sloan Research Fellowship in Neurosciences, 1975–1977.

9 November 1976; revised 25 January 1977

Infrared Reflectance in Leaf-Sitting Neotropical Frogs

Abstract. *Two members of the glass-frog family Centrolenidae (*Centrolenella fleischmanni, C. prosoblepon*) and the hylid subfamily Phyllomedusinae (*Agalychnis moreletii, Pachymedusa dacnicolor*) reflect near-infrared light (700 to 900 nanometers) when examined by infrared color photography. Infrared reflectance may confer adaptive advantage to these arboreal frogs both in thermoregulation and infrared cryptic coloration.*

Many arboreal members of the glass-frog family Centrolenidae and tree-frog family Hylidae are green, and thus cryptically colored when viewed in visible light (400 to 700 nm). Infrared color photography (*1*) reveals that two centrolenids (*Centrolenella fleischmanni, C. prosoblepon*) and two phyllomedusine hylids (*Agalychnis moreletii, Pachymedusa dacnicolor*) also reflect light in the near-infrared region (700 to 900 nm). This is, to our knowledge, the first report of infrared reflectance in neotropical frogs. Since photosynthetic leaf surfaces also reflect infrared, these animals are virtually indistinguishable from the leaves on which they sit, both in visible and near-infrared light ranges. All other

North American frogs so examined [*Bufo debilis, B. boreas* (*2*), *B. coniferus; Rana pipiens* (*2*), *R. palmipes, R. catesbeiana; Hyla cinerea, H. squirella, H. euphorbiacea, H. chaneque*, and *H. cyanomma*] absorb infrared light and stand out sharply against foliage (Fig. 1).

Cott (*3*), using black and white infrared film, found that the Australian tree-frog *Hyla coerulea* (=*Litoria caerulea*) reflects infrared light. *Litoria caerulea, A. moreletii*, and *A.* (=*Pachymedusa*) *dacnicolor* all contain a newly discovered red pigment in unusual melanosomes (*4*). Both *fleischmanni* and *prosoblepon* groups of *Centrolenella* contain a purple pigment in their chromatophores (*5*). Whether these two skin pigments are identical, or play any role in infrared reflectance, has not been determined.

There are two likely functions for infrared reflectance in leaf-sitting frogs. (i) Although the near-infrared is not heat (*6*), photons of these wavelengths will lose energy as heat if they are absorbed by the skin. Thus, the ability to reflect infrared may play a physiological role in thermoregulation by preventing excessive heat gain. (ii) Infrared reflectance may conceal frogs from predators with infrared receptors (*3*). Little research has been done on near-infrared sensitivity, and supportive evidence is sparse. Both the eyes of birds and the pit organs of snakes may act as near-infrared light receptors. In pigeons and chickens, the sensitivity maxima of the eyes are shifted toward longer wavelengths than those of humans (*7*), and the tawny owl responds to infrared light (900 nm) (*8*). Visual sensitivity extending just into the near-infrared would allow birds to see most green frogs on green leaves, although centrolenids and phyllomedusines would remain camouflaged. Boid and crotaline pit organs are usually interpreted as thermal detectors, adaptations for nocturnal predation on warm-blooded prey (*9*). In diurnal snakes, however, these receptors may be used to detect frogs that act as infrared sinks among leaves that are reflecting light of these wavelengths. The facial pits of crotaline snakes are directionally sensitive and may allow infrared depth perception (*10*). Many species of birds and snakes are known to eat frogs and forage in their diurnal retreats. Predation by birds and snakes may have selected for infrared cryptic coloration in tropical leaf-sitting frogs.

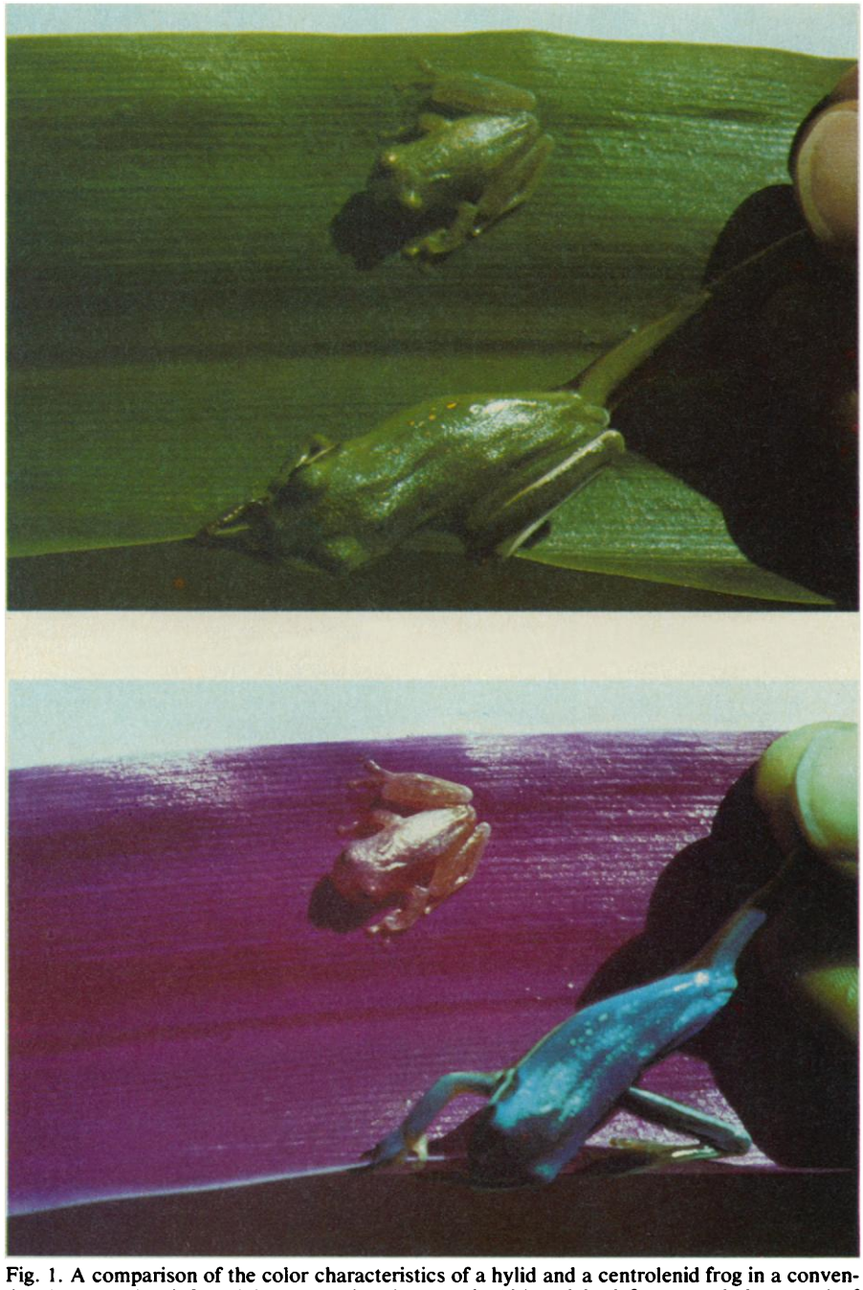

Fig. 1. A comparison of the color characteristics of a hylid and a centrolenid frog in a conventional (top) and an infrared (bottom) color photograph. Although both frogs match the green leaf in light ranges visible to man, only *Centrolenella fleischmanni* (top frog) reflects near-infrared light. This allows it to blend with foliage both in the visible and near-infrared ranges of light, unlike *Hyla cinerea* (bottom frog), which absorbs infrared and is distinguished from the leaf surface in an infrared photograph.

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18 November 1976; revised 17 January 1977

Naloxone in Chronic Schizophrenia

Abstract. *The specific narcotic antagonist naloxone (0.4 milligram) was given intravenously to seven chronic schizophrenics who reported that they had very frequent auditory hallucinations. Saline solution was used as a placebo. The coded study did not reveal any effect of naloxone on hallucinations or on global psychopathology.*

The recent discovery of endogenously produced opioid peptides (*1*) called endorphins has been followed by the hypothesis that these substances may be implicated in the pathophysiology of schizophrenia (*2*). This hypothesis is supported by the following findings: (i) An endorphin has elevated levels in the cerebrospinal fluid (CSF) of schizophrenics (*3*). (ii) These levels decrease to normal when the patients improve clinically (*3*). (iii) A specific opiate antagonist (naloxone, 0.4 mg, given intravenously) reverses schizophrenic hallucinations (*2*). The main purpose of our study was to verify the therapeutic effect of naloxone in schizophrenic hallucinations.

Seven hospital patients (six females and one male) meeting the standard diagnostic criteria for schizophrenia (*4*) were the subjects. All patients reported having very frequent auditory hallucinations; six of them hallucinated continuously. The age range was 24 to 50 years, the duration of illness was 4 to 30 years. Four patients were diagnosed as paranoid, and three were diagnosed as undifferentiated schizophrenia. All patients were receiving antipsychotic medication before and during the experimental period.

Two psychiatrists using a modified Brief Psychiatric Rating Scale (*5*) (BPRS) interviewed the patients. All interviews were videotaped. Three such interviews occurred within the week preceding the start of the experiment. The patients were then given an intravenous injection of either 0.4 mg of naloxone or of a placebo (0.9 percent saline). The BPRS interviews were held immediately before each injection and then at 5 minutes, 30 minutes, 1 hour, 2 hours, 3 hours, 4 hours, and 24 hours after the injection. Each patient received at least one injection of naloxone and one of placebo. The injections were given 24 to 72 hours apart, at the same time of day, in a semirandomized order. Coded procedures were observed throughout the experiment. The results of the first two injections are displayed in Figs. 1 and 2. No average difference between naloxone and placebo was seen. Two patients reported a decrease of hallucinations after having been given placebo. However, two other patients showed a slight reduction of hallucinations after naloxone, without any response to placebo. To test the stability of these findings, one of these "responders" was given an additional injection of 0.4 mg of naloxone without any effect.

The other "responder," however, again improved after an additional injection of naloxone (0.4 mg). This patient subsequently received five injections of placebo, three injections of 0.8 mg of naloxone, and one injection of 1.2 mg of naloxone, in a semirandomized order. The results do not demonstrate any systematic difference between the effects of naloxone and placebo. We therefore conclude that the slight reduction of hallucinations in this patient after the first two injections of naloxone was a function either of chance or of a placebo effect.

In view of the fact that we failed to see any effect of naloxone, we hypothesized that our drug might have deteriorated in storage. We have therefore tested its potency in rats and found that it did have the expected antagonist action (*6*).

We conclude that the report (*2*) of reversal of schizophrenic hallucinations by naxolone cannot be replicated. Although our patient sample was similar to that described in (*2*) in average age and duration of illness, some other differences between the patient sets may have contributed to the divergent results. In contradistinction to Gunn *et al.* (*2*), we have used coded procedures, and

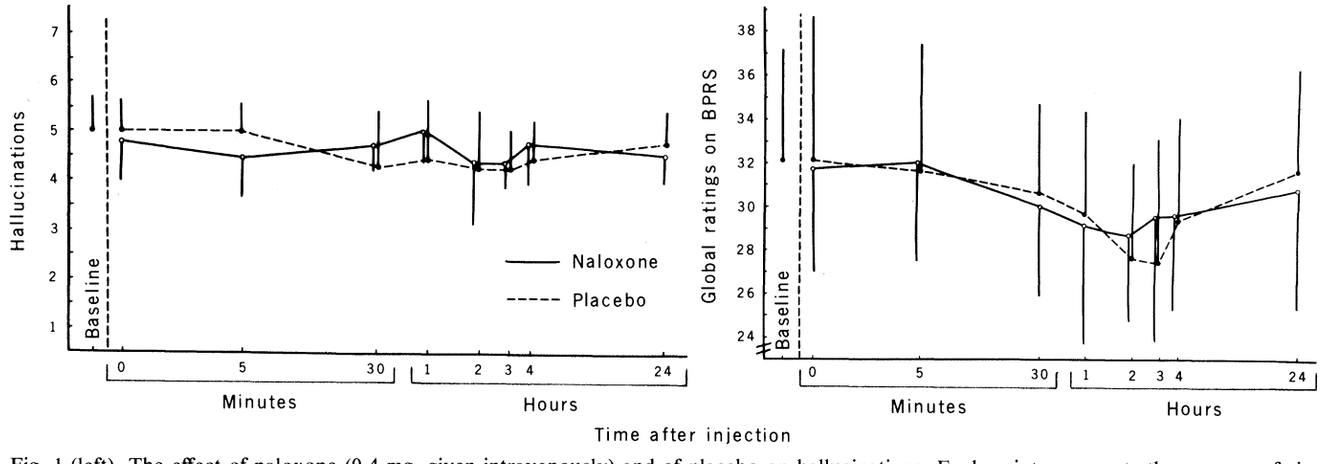

Fig. 1 (left). The effect of naloxone (0.4 mg, given intravenously) and of placebo on hallucinations. Each point represents the average of six patients. (One patient is not included because she did not hallucinate continuously during the baseline assessments.) The baseline measure represents the average of three interviews held in a period of 1 week. The vertical lines represent standard deviations. The scale for hallucinations ranges between 1 (absent) and 7 (extremely severe). Fig. 2 (right). The effect of naloxone (0.4 mg, given intravenously) and of placebo on the global modified BPRS score (excluding the score item "hallucinatory behavior"). Each point represents the average of the seven patients. The vertical lines are standard deviations. The minimal global score (no psychopathology) is 15; the maximum is 105.