



Fig. 3. Corticoid productions in vitro after noxious stimuli were administered to rats bearing atropine implants in the anterior hypothalamus. In all instances the stimuli were presented 45 minutes after implantation; the time intervals indicated are between stimulus and decapitation. Normal responses to the two stimuli are also indicated.

corticoid levels by systemic administration of atropine (7).

Although there is now some evidence of a central cholinergic mechanism that activates the adrenocortical system, Naumenko (8) has suggested that cholinergic agents stimulate this system indirectly by way of some peripheral effect. Our results are not in agreement with this view since the atropine implants are completely ineffective if made in hypothalamic areas other than the one we have described. The significance of involvement of a central cholinergic mechanism in the control of release of ACTH is also accentuated by the apparent lack of a comparable adrenergic mechanism, as is indicated by the demonstration that depletion of hypothalamic catecholamines does not modify stress-induced secretion of ACTH (9).

Further experiments were performed to determine whether the atropine could prevent the responses to stimuli presented 45 minutes after implantation, by which time the blockage was well established. Under these conditions the response normally observed 15 minutes after exposure to ether was completely abolished (Fig. 3); the same was true 30 minutes after injection of arginine vasopressin, but the 15-minute response to arginine vasopressin was only slightly though significantly diminished.

Thus in atropine-implanted rats arginine vasopressin, unlike ether, can still cause release of ACTH, although the magnitude and duration of the response are decreased. The different patterns of responses observed after ether and after arginine vasopressin may

conceivably be ascribed to either differing degrees of intensity or different sites of action of these stimuli. Our data cannot conclusively distinguish between these two possibilities, but they seem to favor the latter.

The responses to ether and surgical stress were apparently mediated by way of the structures in the anterior-dorsal area of the hypothalamus, since these responses were consistently abolished by implantation of atropine in this region. Although our results do not indicate the precise location of the site of action of vasopressin, other results have indicated either a direct pituitary-stimulating effect (10) or an action on the tuberal part of the hypothalamus (11). The transient release of ACTH that we observed after injection of arginine vasopressin in atropine-implanted animals is consistent with the suggestion that arginine vasopressin acts on a structure distal to the site of the atropine implant.

Very few data are available from stimulation and ablation studies involving the specific area of the rat hypothalamus that contained our atropine implants; we know of only one instance in which the lesions employed occupied the same site and yet did not impinge upon the median eminence region (12). Such lesions inhibited secretion of ACTH in response to a wide variety of stimuli; this observation supports the contention that our atropine implants were inhibiting a stimulatory pathway rather than activating an inhibitory pathway.

G. A. HEDGE

P. G. SMELIK

Department of Pharmacology, Medical Faculty, University of Utrecht, Vondellaan 6, Utrecht, Netherlands

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Physical Support with and without Optical Support: Reaction to Apparent Depth by Chicks and Rats

Abstract. *The locomotor reactions to apparent depth made by chicks and rats were measured in situations offering physical support with and without optical information for support. Chicks avoided an optical void though it provided physical support. Rats responded indifferently to the presence or absence of optical information for support as long as physical support was available.*

Although normally treated terrestrial animals of all species tested have exhibited depth perception on the visual-cliff apparatus (1)—a device designed to control for tactual, auditory, and olfactory cues, forcing animals to respond solely on the basis of visual cues—it is likely that the effectiveness of certain classes of visual stimuli for depth perception is greater for some animals than for others. Several obvious species differences point to this: all species do not attain the same level of optical proficiency; they may possess varying sensory anatomies, and may characteristically habituate in differently illuminated environments. For example, the day-active chick manifests correlated visual and locomotor abilities shortly after hatching, while the nocturnal rat requires a period of development in order to perform adequate visual-motor activities. Moreover, some structural differences suggest sensory dominance: some animals may react on the basis of non-visual cues to a situation offering both visual and nonvisual information. Thus, the rat possesses vibrissae which may engender a haptic orientation in exploration. In these same terms, the fact that small birds give over a relatively high proportion of the head to the eyes (2) suggests that the locomotion of the chick may be predominately controlled by optical information. "Optical dominance" for the chick is further indicated by the fact that locomotor activity ceases when optical stimulation ceases, as in total darkness. If it can be generally assumed that the effectiveness of certain classes of stimuli varies with the anatomy, ecology, and biological requirements of the species, then a reasonable prediction is that some relevant differences between these two species will be reflected by different responses to physical support with and without

optical information for support when these two forms of stimulation can be experimentally isolated.

Tests on the visual-cliff, where the response measure is "place of descent"—to the "deep" or the "shallow" side—are generally insensitive to differences in sensory systems. An alternative response-measure enables a meaningful species comparison with respect to reactions to apparent depth. This measure is the reaction to apparent depth in a situation where there is "physical support" without corresponding "optical support." Optical support refers to optical information for support and has been defined as "a relatively coarse optical texture of an array surrounding the animal's feet" (3). Physical support refers to actual support—stimulation of the haptic system by the surface physically supporting the animal. Obviously, physical support is generally accompanied by optical support; however, it is possible to eliminate optical support without eliminating physical support.

The apparatus used for this was a modified version of the visual-cliff [model II, illustrated in Walk and Gibson (3)]. It was a hollow, rectangular box of gray wood, 81 cm long, 51 cm wide, and 24 cm high, with a continuous floor of glass. Patterned material composed of 12.7-mm-wide red and white checks was inserted directly under one half of the glass floor (shallow side). The same patterned material was placed on the laboratory floor, 51 cm below the other half of the glass floor (deep side) and provided a continuously textured surface when viewed from the initial placement on either the deep or shallow side. Unlike the standard visual-cliff testing situation, no start platform, centerboard, or other separating structure in the deep-shallow plane was employed. Lighting was from fluorescent lamps covered with diffusing milk glass and white cloth sheeting. Small incandescent lamps fastened to the outside of the apparatus were adjusted to equate the illumination of the deep and shallow sides. Illumination was approximately 6 ft-ca (66 lu/m²). Control measures, such as the placement position of the animals and observation position, were appropriately taken. Commercially obtained day-old and week-old male chicks, 60-day-old Holtzman strain albino male rats, and 60-day-old Long-Evans strain hooded male rats were the subjects. All chicks

Table 1. Performance of animals on the shallow-deep plane.

Placed on deep				Placed on shallow			
N	Number making no response	% Moving:		N	Number making no response	% Moving:	
		Toward shallow	On deep			On shallow	Toward deep
73	2	92	8	41	1	95	5
			<i>1-day-old chicks</i>				
37	16	100	8	27	9	100	
			<i>7-day-old chicks</i>				
46		43	57	34		41	59
			<i>60-day-old hooded rats</i>				
46		48	52	40		38	62
			<i>60-day-old albino rats</i>				

were dark-hatched; those tested at 1 day of age were kept in a light-tight brooder until testing. Chicks tested at 7 days of age were maintained in wire mesh brooders, located on the floor of the laboratory.

The animals were placed on the transparent glass surface of either the deep or shallow side, 6 cm from the center of the box, in a line parallel to the edge of the textured side which divided the shallow-deep plane. The occurrence and orientation of the animals' locomotion provided the data of the experiment. A trial ended when the animal made a nonlateral locomotor movement—moved away from or crossed over the median of the shallow-deep plane—or when 3 minutes for the rat and 5 minutes for the chick had elapsed. A response consisted of at least two steps for the chick and a locomotive movement of all four paws for the rat. Thus, an animal placed directly on the deep side, 6 cm from the shallow surface, was situated in an environment offering physical support without corresponding optical support. A movement by the animal toward the textured surface, placing the pattern beneath its feet, would indicate a response to obtain optical support. On the other hand, no such reaction to apparent depth by an animal would suggest that the available tactual stimulation is sufficient to mediate its locomotion. In a similar vein, animals placed on the shallow side, 6 cm from the deep side, faced with a continuous surface of tactual stimulation should respond depending on the importance of optical stimulation. Optically dominated animals should avoid the deep half of the glass floor, keeping a source of optical support directly beneath them, while tactually dominated animals should not show the avoidance reaction

and perhaps freely explore the deep surface which offers a continuous plane of tactual, but not visual stimulation.

Table 1 presents a summary of the main findings. There was a significant difference in the direction of locomotion when chicks were placed on the deep side and on the shallow side. When placed on the deep side the majority of 1-day-old and 7-day-old chicks ($z = 6.89, P < .001$, and $z = 4.37, P < .001$, respectively) moved to the shallow side, supporting the assertion that chicks are responsive to a lack of optical support. This was further indicated by the immediate reactions of the chick to being suspended over a void, namely, a spread-eagled stance. The few cases in which the chick remained and moved on the deep surface, it either jumped about or exhibited a peculiar high-stepping gait. When chicks were placed on the shallow surface, only two chicks jumped to the deep side (shallow-deep difference for 1-day-old chicks: $z = 5.55, P < .001$; for 7-day-old chicks: $z = 4.01, P < .001$). The major response difference between the two ages of chicks was in the number of animals not responding. A higher number of 7-day-old chicks made no locomotor response in the 5-minute observation period ($\chi^2 = 26.55, P < .001$ for chicks placed on the deep side; $\chi^2 = 10.05, P < .005$ for chicks placed on the shallow side), suggesting that nonresponsive reactions to an environment involving a potential drop increase with age.

The direction of locomotion of the two species of rats when placed on either the deep or shallow side did not significantly depart from chance expectancy. There was no difference between placement and direction of locomotion ($z = .74$ and $z = .15$, for initial placement of hooded and albino rats, respec-

tively, on the deep side; $z = .86$ and $z = 1.42$, for hooded and albino rats, respectively, for initial placement on the shallow side). Moreover, there was no species difference in response behavior between albino and hooded rats ($\chi^2 = .04$ for deep placement; $\chi^2 = .01$ for shallow placement). Though there appears to be a tendency for rats to move "on" or "toward" the deep side, depending on initial placement, the locomotion responses, summing over species, did not depart from chance expectancy ($z = .73$ and $z = 1.74$, for rats placed on the deep and shallow sides, respectively). The results indicate that a lack of optical support is of little concern to the rat, as long as tactual stimulation is available.

It is clear from the data that chicks and two species of rats differ in their reactions to the presence or absence of optical texture surrounding their feet. The chick avoids an optical void even though physical support is provided; the rat, on the other hand, is indifferent to a lack of optical information for support when physical support is provided. This helps explain why rats *ever* descend from a centerboard of a visual-cliff to the deep side; there is evidence that this presumably maladaptive response increases with a decrease in the height of the centerboard (4). This, coupled with the present findings, indicates the intrusion of tactual stimulation in a presumably visual task. Only when tactual information from the surface is eliminated, as in the case of a relatively high centerboard, can the choice of descent for a rat on the visual-cliff be attributed to the utilization of visual information.

Results concurring with those presented here have been obtained by employing a different procedure and examining a different response measure. Walk and Gibson (3), and Walk (5) report incidental and quantitative data, respectively. Indirectly, these investigators have observed that chicks, but not rats, exhibit fear reactions to placement on the deep side of a standard visual-cliff apparatus. Walk placed 90-day-old hooded rats and 3- to 4-day-old chicks on the glass of either the deep or shallow side and measured the latency of a forward locomotion. His results indicate greater "fear of high places" for the chick than for the hooded rat; that is, only in the case of the chick did the median latency for a forward locomotion on the deep side

significantly exceed the median latency when it was placed on the shallow side.

The technique described here is a comparative one, useful for studying reactions to apparent depth in a wide range of animals and for quantifying species differences on the basis of visual or haptic dominance. To what extent and under what conditions such sensory dominance exists for these and other testable species are questions for further study.

H. R. SCHIFFMAN

*College of Arts and Sciences,
Rutgers-The State University,
New Brunswick, New Jersey 08903*

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Cells Related to Fighting Behavior Recorded from Midbrain Central Gray Neuropil of Cat

Abstract. *Cells were recorded in the midbrain central gray neuropil of the cat that responded with action potentials only during fighting behavior and not while the cat was resting or while control manipulations were performed. Some other cells in the same region responded maximally during fighting, and all cells responded to at least one manipulation. Brain stimulation at sites of cells related to fighting caused the animals to hiss.*

The central gray neuropil surrounding the aqueduct of Sylvius in the midbrain is related to fighting behavior in the cat. Electrical stimulation of this region elicits hissing, dilation of the pupils, piloerection, and a well-directed striking or biting attack (1, 2). Lesions confined to this region can abolish, at least for several weeks, similar behavior elicited by a barking dog (2, 3). I have attempted to locate, and to record from, the cells responsible for these phenomena.

The responses of single cells were recorded during fighting behavior elicited by confrontation of the cat with a second attacking cat. Until an attack the attacking cat remained on the other side of a partition from that from which records were being taken; then the partition was opened, the brain of the attacking cat was stimulated to produce hissing and striking, and the animal was moved toward the second cat until this cat responded with hissing, or striking, or both. The response of each cell was also recorded during control manipulations of the cat including presentation of clicks and flashes, lifting and dropping of the cat, pinching of its tail, and retraction of cat's foreleg after it had been extended by the experimenter.

Most cells encountered in and around the midbrain central gray neuropil were highly active when the cat was fighting. The firing rates of 32 cells recorded in 11 cats increased from a median baseline rate of 0.2 action potentials (spikes) per second to a median rate during fighting of 12.0 spikes per second. Most of these cells also responded to a variety of control manipulations of the cat and were not maximally active during fighting. A few were particularly responsive to perception of visual movement (cells in the superior colliculus or near the oculomotor nucleus), to auditory stimuli, or to head movement. Four cells, however, responded only during fighting, and five others responded maximally during fighting. No cells which were primarily inhibited or which were unresponsive to any manipulation of the cat were recorded in this region. Cells which fired only or maximally during fighting were found in five cats, whereas cells which fired only during fighting were found in three.

Three of the four cells which fired only during fighting were found within the central gray neuropil immediately dorsal or lateral to the aqueduct of Sylvius. These cells never fired while the cat was resting, and they did not