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Effects of Ethyl Alcohol on Hypothalamic Affective Defense in the Cat

G. JOHANSSON, A. HUHTALA AND M.-L. LAAKSO

Department of Physiology, University of Helsinki, Siltavuorenpenger 20 J SF-00170 Helsinki 17, Finland

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JOHANSSON, G , A HUHTALA AND M -L LAAKSO. *Effects of ethyl alcohol on hypothalamic affective defense in the cat* PHARMACOL BIOCHEM BEHAV 20(6) 841–844, 1984.—Hypothalamic stimulation was used to elicit affective defense in the cat The behavior was recorded by direct observation and a video tape recorder, and different components thereof were evaluated on a rating scale. The effect of ethyl alcohol, 0 25, 0 5, 1.0 and 1 5 g/kg body weight, on behavior was studied Doses of 0 25 and 0.5 g/kg had no clear effect; 1.0 and 1 5 g/kg depressed the majority of the rated components

Alcohol Ethanol Affective defense Aggression Agonistic behavior Hypothalamus Electrical stimulation Cat

THE common belief that ethyl alcohol (EA) induces or increases aggressive behavior is supported by human studies [3, 9, 20, 23, 24]. However, the reliability of such studies has been criticized, even opposite results have been reported [1,15]. Apparently, research on the effect of EA on aggressive behavior in man has limitations, and evaluations are difficult to make

Attack and affective defense elicited in animals by direct stimulation of hypothalamic brain structures (e.g., [4, 6, 18]) afford a well-controllable model on which the effects of EA can be studied. Such animal studies are, however, few [12, 13, 14].

The aim of the present investigation was to study the effects of EA on affective defense in the cat elicited by electrical stimulation of the ventromedial hypothalamus.

METHOD

Animals

Altogether twenty-four male cats were used in the experiments. Fourteen cats were used in pilot tests where the effects of EA on normal behavior and blood EA concentration were studied In sixteen out of these twenty-four cats, electrodes were permanently implanted into the ventromedial hypothalamus. The weights of the latter cats ranged from 2.5 to 4.0 kg. During the stimulation experiment, a second cat was always kept with the experimental animal. All the cats had been living in a colony of 15 to 30 animals for at least 4 weeks before onset of the experiment.

Electrodes, Surgical Procedure, Electrical Stimulation and Apparatus

The electrodes used for stimulation and the operative procedure have been described in detail previously [6] Electrical stimulation was carried out in a continuously ventilated observation box (100×80×70 cm) in an empty laboratory (all personnel and apparatus being in another room). The front of the box was made of Plexiglas. The stimulator (Nihon Kohden, Type MSE-3R) was of the "constant voltage" type. The current of the square wave impulses through the electrodes was measured by reading the potential across a 1000-ohm resistor interposed in series in the stimulation circuit Constant parameters of the pulses were: pulse duration 1 msec, frequency 50 pulses/sec, train duration 10 sec. The pulses were monitored on a dual beam oscilloscope (Tektronic Type 502 A).

The behavior of the cats was continuously monitored and recorded by means of a television camera (Studiocamera "Teledict") and a video tape recorder (Shibaden SV 800 E). Direct observations were also made during stimulations through a hole in the laboratory wall. The behavior of the animals was rated by specific criteria (Table 1) In a previous study [7], a reliability check on the rating procedure was made. The correlation coefficient based upon blind ratings of behavior from the video tape by the regular observer and an independent observer was r=+.86.

Pilot tests including behavioral observations and blood EA concentration determinations were made after completion intravenous infusion of saline solution 3.7 cc/kg body weight containing 0.25, 0 5 and 1.0 g EA/kg body weight at different time intervals in 14 cats.

Experiments

Each experiment was started in the afternoon, 4 hours after last meal of the cat. The cat to be stimulated was placed in the observation box with another cat and connected to the cable of the stimulator The animals were allowed to adapt to the test situation for at least 15 min before any stimulation was applied. Three stimulations with a pulse intensity high enough to produce either hissing or attack or both were given at intervals of at least 5 min.

TABLE 1
RATING CRITERIA FOR BEHAVIORAL COMPONENTS

Component	Rating 0	1	2	3
Behavioral Alerting	No observable alerting	Reacting to stimulation by freezing and/or slight movement. The animal gave the impression of being surprised, and observed its surroundings with or without moving the head	Moving slowly round the cage searching and sniffing	Moving around violently
Piloerection	No observable piloerection	Slight piloerection on the tail	Apparent piloerection on the tail and the midline of the neck	Strong piloerection all over the body
Hissing	No hissing	Slight hissing	Moderate hissing	Strong hissing
Fighting	No fighting	Defensive strikes with the fore paw	Moderate fighting	Vigorous fighting
Biting	No biting	A single bite	Several bites	Biting throughout the stimulation time
Claws	No claw protrusion			Protrusion of the claws
Retraction of the ears	No retraction	Ears slightly retracted	Ears clearly retraced but not flattened against the head	Ears close against the head

Seven different behavioral components were evaluated on a rating scale (Table 1). Thereafter saline solution 3 7 cc/kg body weight was slowly (2–3 min) administered intravenously. The order of the infusion was randomized, and the observer recording the behavior did not know which EA dose had been given. Twenty, 25 and 30 minutes after the end of the infusion period the stimulation program was repeated with the same stimulation intensity as before. Infusions containing 1.5 g EA/kg was performed in only five cats. The cats were allowed to rest for at least 5 days between experiments.

Evaluation of Responses

The preinfusion score for a particular response observed in each animal was calculated as the average of three stimulations. Similarly, a postinfusion score was the average of the three stimulations performed 20, 25 and 30 min after the end of the infusion. The Wilcoxon matched-pairs, signed ranks test was applied to statistical analysis of the results [21].

TABLE 2
EFFECTS OF ETHYL ALCOHOL ON BEHAVIORAL COMPONENTS IN THE CAT ELICITED BY ELECTRICAL STIMULATION OF THE VENTROMEDIAL HYPOTHALAMUS

	Saline	0 25 g Ethanol/kg	0 5 g Ethanol/kg	1 0–1 5 g Ethanol/kg
Behavioral alerting	(−)	(−)	Decrease ($p<0$ 01)	Decrease ($p<0$ 01)
Piloerection	(−)	(−)	(−)	Decrease ($p<0$ 01)
Hissing	(−)	(−)	(−)	(−)
Fighting	(−)	(−)	Decrease ($p<0$ 05)	Decrease ($p<0$ 01)
Biting	(−)	(−)	(−)	Decrease ($p<0$ 01)
Claws	(−)	(−)	(−)	Decrease ($p<0$ 01)
Retraction of the ears	(−)	(−)	(−)	Decrease ($p<0$ 01)

Wilcoxon matched-pairs, signed ranks test [21]
(−)=no change.

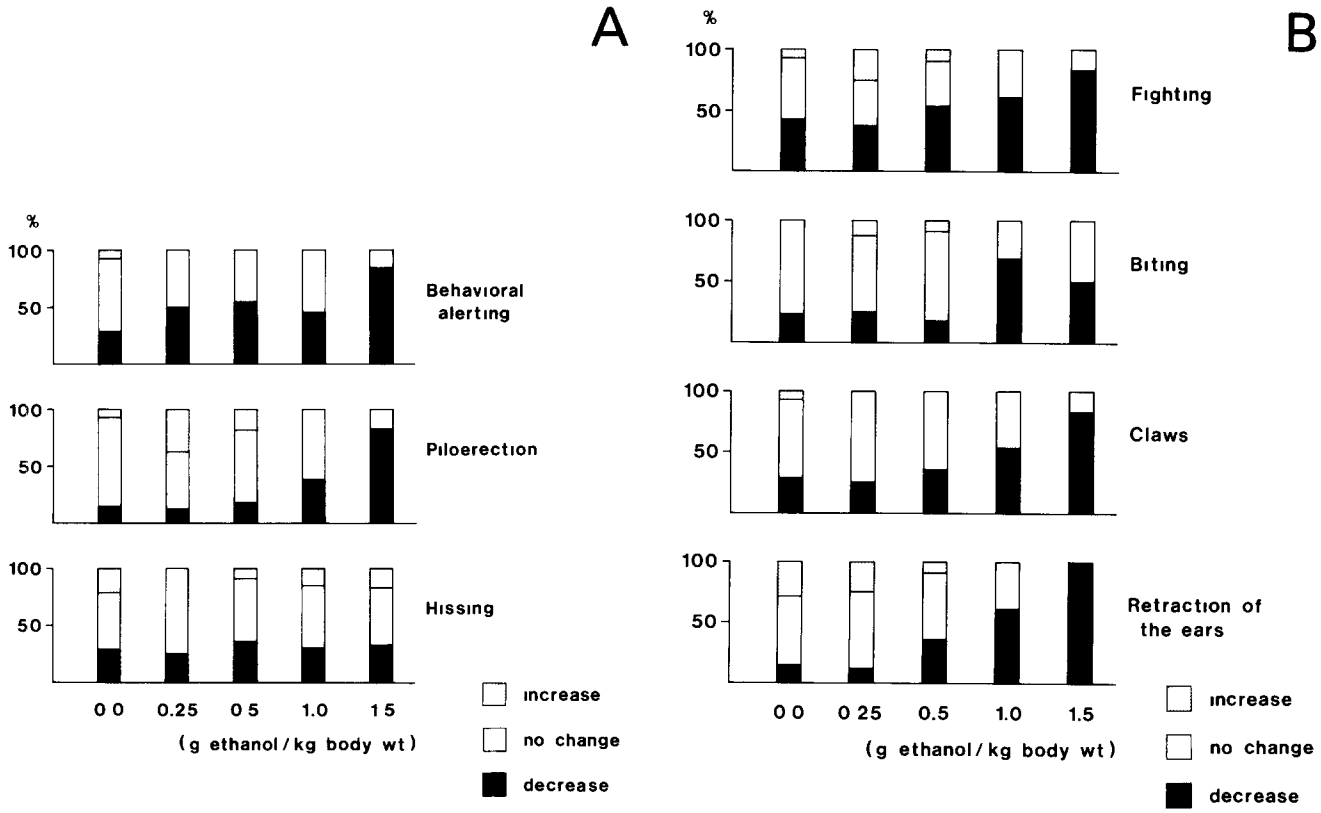

FIG 1 Percent of cats in which ethanol decreased (■), did not decrease (□) or increased (dotted box) the intensity of different behavioral components elicited by electrical stimulation of the ventromedial hypothalamus

RESULTS

Responses to Electrical Stimulation of the Ventromedial Hypothalamus Before Ethyl Alcohol Infusion

The behavior elicited by stimulation resembled the affective defense behavior elicited from the hypothalamic defense area described by several previous authors (e.g., [4, 6, 18]). The highest preinfusion mean score, according to our rating scale, was obtained for behavioral alerting followed by piloerection and protrusion of the claws.

Clinical Effect of Ethyl Alcohol on the Normal Behavior of the Cat 20–30 Min After Intravenous Infusion

There was no observable change in the cat's normal behavior after an EA dose of 0.25 g/kg (mean blood concentration 0.035%, two determinations). The infusion of 0.5 EA/kg, 0.054% (N=4), led to slight decrease in alertness in some of the cats; 1 0 g/kg, 0.13% (N=8), always resulted in drowsiness with slight motor incoordination. The highest dose of EA, 1.5 g/kg, (no determinations) produced a semiconscious state with heavy disturbance of motor coordination and nystagmus.

Postinfusion Stimulation Responses

Saline and ethanol 0.25 g/kg. No significant effects on any of the behavioral components (Table 2 and Fig. 1A and B).

Ethanol 0 5 g/kg. The scores for behavioral alerting and fighting were lowered in most cats, the changes being considered significant at the level of $p<0.05$ (Table 2 and Fig. 1A and B) A slight (but not significant) decreasing tendency was seen also in the other components (Fig. 1A and B).

Ethanol 1.0 and 1 5 g/kg. Both doses had a clear response-decreasing effect. This change was significant for all other components but hissing (Table 2 and Fig. 1A and B)

DISCUSSION

Although the blood level of EA rises quickly after an intravenous infusion, we found in our pilot studies that this immediate rise was very variable as was the spontaneous instant postinfusion behavior of the cat. The blood level of EA as well as the spontaneous behavior of the cat stabilized 20–40 minutes after the completion of the EA infusion. Therefore we decided to perform the postinfusion stimulations at 20, 25 and 30 minutes.

The dominant effect of EA on sensory functions (visual, auditive, touch and pain perception) has in most cases been shown to be depressant (cf., e.g., [25]). On the other hand, the effects of EA on the central nervous system, as measured electrophysiologically, seem to be biphasic: low doses excite and high doses depress activity (reviewed in [5, 8, 25]). This dual effect has been more difficult to verify in complex behavior, such as occurs during conflicts. In general, aggressive or affective defense behavior has been reported to remain largely unaffected or suppressed by EA in laboratory animal studies (e g., [10, 11, 16, 19, 22]). However, some indications of enhancement of irritative behavior or of components thereof after EA administration can be found in the literature. Raynes *et al* [17] found EA (0.3% in water) to increase aggressive behavior in Siamese fighting fish.

Further, EA has been reported by some authors to increase spontaneous social interactions under certain circumstances in mice and rats [2, 10, 16]. Masserman and Jacobson [14], eliciting affective defense behavior in the cat by hypothalamic stimulation, reported that EA (0.8 to 2.4 g/kg IV) lowered the stimulation threshold, i.e., increased the strength of the response. This result is interesting, since in the present study a dose as low as 1.5 g EA/kg IV brought the cat into a semiconscious state with increased (not decreased) electrical stimulation threshold and, consequently, decreased behavioral response. This was actually the reason why we tested this dose in five cats only. MacDonnell and Ehmer [12] reported that the force of biting was the only component of attack behavior (i.e., quiet biting attack [26]) induced by stimulation of the lateral hypothalamus that increased after administration of EA (0.37–1.5 g/kg). The intensity of the other components decreased and latency between onset of stimulation and attack became longer. In a study on the effects on EA on affective defense elicited by stimulation of the ventromedial hypothalamus in the cat, MacDonnell, Fessock and Brown [13] reported moderate doses (0.37 g/kg) to decrease hissing latency. The hissing intensity was the only component which remained unchanged in the present study. We did not, however, measure hissing latency.

The biphasic effect of EA on the central nervous system can hardly be disputed, the initial effect seems to be exciting, but the long lasting and dominating effect, on the other hand, depressive. Direct observations of affective or aggressive cats, in which these states, are artificially induced by brain stimulation ([12,13], the present study) or more naturally by the attack of another cat [19], give no support for any aggression-increasing effect of EA (except [14]).

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