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Drug-Induced Ataxia in Opponents Elicits "Pathological" Fighting in Undrugged Rats Exposed to Footshock

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ELLIOTT, M. L. AND R. J. SBORDONE. *Drug-induced ataxia in opponents elicits "pathological" fighting in undrugged rats exposed to footshock.* PHARMAC. BIOCHEM. BEHAV. **16**(1) 63–66, 1982.—One member of a pair of rats was administered either mescaline, lysergic acid diethylamide (LSD), pentobarbital, or ethanol intraperitoneally twenty minutes prior to exposure to footshock in the presence of an undrugged opponent. At high doses, all drugs elicited biting from the undrugged rat of sufficient intensity to produce injury to its drugged opponent. Low doses produced species-typical fighting behavior which consisted of striking each other with their forepaws while upright and failed to elicit biting. Biting attacks by the undrugged rat were highly correlated with ataxic behavior by the drugged rat. Conversely, species-typical aggressive behavior was highly correlated with behaviors such as boxing or upright threat posture. These results suggest that drug-induced ataxic behavior may disinhibit mechanisms that regulate intra-species behavior, thus producing behavior that is more typical of inter-species aggression.

Footshock Aggression Hallucinogens Ataxia Alcohol Pentobarbitol

THE administration of a drug to one member of a pair of rats in a shock-elicited fighting situation will significantly alter the topography of fighting behavior of the undrugged opponent. For example, drugs such as mescaline [10], pentobarbital [11], and procaine [4] change the topography of fighting behavior in the undrugged rat from the relatively innocuous behavior of striking the drugged opponent with its forepaws to injury-producing biting. Similar results have been observed in a food competition situation following the administration of alcohol [8] or delta^9-THC [7]. This phenomenon has also been reported in mice following the administration of chlorpromazine to isolation-raised male mice [3], and chlordiazepoxide [2] in a home-cage intruder situation.

Sbordone and Elliott [11] studied the temporal relationship between the behavior of a pentobarbital (20 mg/kg IP) treated rat and an undrugged opponent during footshock exposure. They found that species-atypical behaviors by the drugged rat such as ataxic movements often immediately preceded biting by the undrugged rats. Conversely, species-typical behaviors such as upright threat postures and locomotion often immediately preceded boxing attacks, but rarely preceded biting. Sbordone and Garcia [10] had previously reported a similar relationship between the behavior of the mescaline-treated rat and the topography of aggressive behavior of its undrugged opponent based on visual observation. Sbordone and Elliott [11] suggested that the degree to which a drug treatment elicits biting in untreated rats may be a function of the degree to which the drug produces ataxic behavior in a situation where aggressive behavior is likely to occur. However, this hypothesis was based on observations with only two drugs (one at only a single dosage level). Therefore, the generality of the phenomenon, as well as the hypothesis, was unknown.

The present study attempted to determine the generality of the phenomenon by administering two hallucinogenic drugs, lysergic acid diethylamide (LSD) and mescaline, and

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two CNS depressants, alcohol and pentobarbital (Nembutal) to one member of a pair of rats prior to exposing both animals to footshock. The temporal relationship of aggressive behaviors of the two opponents was studied throughout the time course of drug action in order to test the hypothesis that ataxic behavior by the drugged rat would elicit biting attacks by the undrugged opponent regardless of the drug which induced the ataxia.

METHOD

Subjects

One hundred experimentally naive male Sprague-Dawley rats between 90–100 days old (380–500 g) (Simonsen Breeding Laboratory, Gilroy, CA). Each rat was housed individually with food and water available at all times.

Apparatus

The aggression test chamber consisted of a transparent plastic cylinder, 30 cm (diameter) by 30 cm (height). The grid floor consisted 0.634 cm stainless steel rods, spaced 1.27 cm apart (center to center). Electric shock from a constant current shock source was delivered to the floor grids through a Davis Model 255 grid scrambler. The behavior of each opponent and the delivery of shock were recorded concurrently on digital counters, electric cumulative timers, and an Esterline-Angus 20-channel event recorder. The latter device provided a permanent record of the victim's behavior with respect to the behavior of the attacker, the sequence of behaviors, and shock delivery. The test chamber was housed in a sound-deadened room adjacent to the room housing the rest of the apparatus. Both observers sat in this adjacent room and observed the test chamber through a window.

Procedure

The subjects were weighed 24 hours prior to testing and paired together on the basis of similar body weight (within 10 g). Each pair was randomly assigned to one of ten treatment groups (5 pairs per group): "high" and "low" dosages of mescaline hydrochloride (10 and 50 mg/kg); lysergic acid diethylamide (20 and 100 mcg/kg); pentobarbital (Nembutal) (4 and 20 mg/kg); ethanol (0.4 and 2 sg/kg), plus two saline (0.9%) control groups (1 and 10 ml/kg). The second control group was needed to match the injection volume of the ethanol group. Twenty minutes prior to testing, one subject in each pair received an intraperitoneal injection of drug or saline which was unknown to both observers. The testing session began immediately after placing both rats in the experimental chamber. Each pair received 100 shocks of 4.0 mA and 1.5 sec duration with an intershock interval of 20 sec. Total length of the testing session was approximately 36 min.

Throughout the session one observer continuously recorded, by pressing at least one of eight microswitches, the behavior of the drugged rat according to the following criteria: ataxic head movements (irregular, uncoordinated, swaying horizontal or vertical head movements); ataxic body movements (irregular, uncoordinated postures and gait disturbances that often resulted in loss of balance and falling to the grid floor); submissive crouch posture (immobile on grid floor with attacker standing over in a dominating position); locomotor activity (non-ataxic movement around experimental chamber); upright posture (standing on hind feet); threat posture (directs body or faces opponent); aggressive behavior (striking or biting opponent); no activity (unconscious or lying motionless on the grid floor). These behaviors were not mutually exclusive since it was possible for the drugged rat to exhibit more than one behavior simultaneously. A Pearson product-momentum correlation coefficient of 0.94 between two observers prior to the start of the experiment indicated that these behaviors were easily observable and distinguishable from each other.

A second observer continuously recorded, by pressing one of six microswitches, the aggressive behavior of the undrugged rat according to mutually exclusive criteria developed by Sbordone and Garcia [10]. A Pearson product-momentum correlation coefficient of 0.99, between two observers prior to the start of the experiment, indicated that these categories were easily observable and distinguishable from each other.

TABLE 1

TEMPORAL RELATIONSHIP BETWEEN BEHAVIOR OF DRUG-TREATED RAT AND THE FIGHTING BEHAVIOR OF UNDRUGGED OPPONENT FOR ALL DRUGS AND DOSAGES COMBINED

Behavior of drug-treated rat within 5 sec of being attacked	Fighting behavior undrugged opponent			
	Boxing		Biting	
	No.	%	No.	%
Ataxic head movements	15	1.1	18	34.6
Ataxic body movements	36	2.5	13	25.0
Submissive crouch	10	0.7	12	23.1
Locomotor activity	83	5.8	8	15.4
Threat posture	223	15.6	0	0.0
Upright posture	651	45.7	1	1.9
Agressive attack	407	28.6	0	0.0
No activity	0	0.0	0	0.0
	1,425	100.0	52	100.0

RESULTS

Inspection of data revealed that little or no aggressive behavior occurred during the period of initial sedation and immediately following high dosages of mescaline, pentobarbital, and ethanol. As the heavy sedation wore off, ataxic movements appeared and were associated with biting attacks to the head and snout of the drugged rat. As the ataxic behavior diminished and the drugged rat resumed normal movements, the frequency of biting by the undrugged rat decreased and both rats engaged in upright boxing postures when footshock was delivered. None of the drugged rats were ever observed to engage in any type of biting behavior towards their undrugged opponent during any part of the experiment.

Table 1 presents the temporal relationship between the behavior of drug-treated rats and the fighting behavior of the undrugged opponent for all drugs and dosages combined. It can be seen that 98.1% of biting attacks by the undrugged rat occurred within 5 sec after the drugged rat had either engaged in ataxic movements, submissive crouch postures, or locomotor activity. These behaviors, however, preceded only 10.1% of the boxing attacks by the undrugged rat. Conversely, behaviors such as upright threat postures, or ag-

TABLE 2

RELATIONSHIP BETWEEN THE TOPOGRAPHY OF AGGRESSIVE BEHAVIOR OF UNDRUGGED RAT AND DRUG TREATMENT OF OPPONENT

Topography of aggressive behavior of undrugged rat toward drugged opponent	Drug Treatment of Opponent									
	Mescaline (mg/kg)		LSD (mcg/kg)		Pentobarbital (mg/kg)		Ethanol (g/kg)		Saline (ml/kg)	
	10	50	20	100	4	20	0.4	2	1	10
	Frequency									
Shoving	3	8	4	13	9	23	14	62	3	7
Boxing	90	30	95	77	111	52	63	34	75	65
Bite Attack	0	17	2	1	2	14	0	36	0	0
Mild Biting	0	6	0	0	0	5	0	10	0	0
Mod. Biting	0	27	0	0	0	2	0	3	0	0
Severe Biting	0	5	0	0	0	4	0	0	0	0

gressive behavior by the drugged rat occurred within 5 sec of 89.9% of the undrugged rat's boxing attacks upon the drugged opponent, and only preceded 1.9% of biting attacks. A chi-square analysis revealed a highly significant difference between behaviors of the drugged rat associated with the boxing and biting behavior of the undrugged rat, $\chi^2=504.55$, $df=3$, $p<0.000001$.

An analysis of the effect of ataxic movements, submissive crouch, and locomotor activity by the drugged rat on the intensity of biting behavior of the undrugged rat revealed that ataxic movements preceded (within 5 sec) 74.2% of biting attacks which either penetrated the drugged rat's skin, or resulted in physical damage. Whereas, this figure was only 30.0% for submissive crouch and locomotor behaviors. A chi-square analysis revealed that this difference was statistically significant, $\chi^2=7.93$, $df=3$, $p<0.01$. The total number of ataxic behaviors by the drugged rat (all drugs and dosages combined) which occurred during the experimental session was found to be highly correlated with the number of bites received from their undrugged opponents, $r=0.832$, $df=48$, $p<0.00001$.

Table 2 presents the topography of aggressive behavior by the undrugged rat and the drug treatment administered to its opponent. A chi-square analysis revealed that high dosages of mescaline, $\chi^2=75.82$, $df=2$, $p<0.00001$, LSD $\chi^2=6.31$, $df=2$, $p<0.05$, pentobarbital, $\chi^2=42.48$, $df=2$, $p<0.00001$, and ethanol, $\chi^2=87.94$, $df=2$, $p<0.00001$, were significantly different from their respective saline controls. None of the lower dosages of these drugs were found to be significantly different from saline controls (all p's>0.30).

DISCUSSION

The behavior of the drugged rat, regardless of the drug and dosage administered, appears to exert a powerful influence in determining the topography of aggressive behavior of its undrugged opponent. There was a strong association between species-atypical biting attacks by the undrugged rat and ataxic movements, submissive behavior, and locomotor activity of the drugged rat in the presence of footshock. Ataxic behaviors alone preceded the majority of biting attacks by the undrugged rat, and were related to more intense biting than either submissive behavior or locomotor activity. Conversely, a strong relationship was found between species-typical boxing attacks by the undrugged rat and behaviors such as upright threat postures, and aggressive behavior in the drugged rat. These results suggest that specific behaviors of a drugged rat such as ataxic movements, rather than any specific characteristic of the drug, are related to species-atypical biting behavior by an undrugged rat in a shock-elicited fighting situation.

Since laboratory rats rarely engage in biting in response to footshock [1, 9, 10, 12], the finding that biting occurs in the presence of a specific set of stimuli would suggest that these stimuli may connote "strangeness" and elicit a topography of aggressive behavior normally reserved for animals of a different species. For example, biting occurs in a shock-elicited aggression situation when an untreated rat is paired with a guinea pig [12]. Conversely, stimuli such as upright behaviors, threat postures, or aggressive behavior may connote "familiarity" and elicit a topography of aggressive behavior normally reserved for members of the same species.

These data are consistent with the results of a previous study by Sbordone and Elliot [11] which reported that pentobarbital-treated rats were bitten by their undrugged opponents immediately after they exhibited ataxic movements and submissive behaviors and bear a striking similarity to a recent finding [5] that potential human victims of assault were characterized by disorganized body movements which appeared to communicate a quality of being different or "strangeness." Conversely, non-victims exhibited organized or harmonious body movements. The data in the present study are also consistent with studies which have reported biting by undrugged rats in a food competition situation following the administration of delta-9-tetrahydrocannabinol [7], and alcohol [8]. They, however, are inconsistent with the results of Krsiak and Borgesova [6] who reported that alcohol treatment decreased the aggressive behavior of undrugged opponents in a home-cage intruder situation. Further work needs to be done to clarify the generalizability of the findings of the present study as well as to examine sensory stimuli which may mediate the influence of ataxic behavior on the aggressive behavior of the undrugged rat.

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