Pharmacology Biochemistry & Behavior, Vol. 26, pp. 61–64, 1987. © Pergamon Journals Ltd., 1987. Printed in the U.S.A. 0091-3057/87 $3.00 + .00

The Effects of Ethanol on the Offense and Defensive Behaviors of Male and Female Rats During Group Formation[1]

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BLANCHARD, R. J., K. HORI, K. FLANNELLY AND D. C. BLANCHARD. *The effects of ethanol on the offense and defensive behaviors of male and female rats during group formation.* PHARMACOL BIOCHEM BEHAV **26**(1) 61–64, 1987.—In order to determine the effects of ethanol on social/agonistic interactions of rats in mixed-sex groups, saline or 0.3, 0.6, or 1.2 g/kg injections of ethanol were given to one male in 3 M, 3 F groups just prior to placement of the animals in a colony situation. Scores of offensive behaviors by the treated males generally declined as a function of dose level, but only with the 1.2 g/kg dose were behavior scores significantly different from the saline control. Ethanol effects on defensive and sexual behaviors were not significant. The proportions of attacks directed at females by males given higher ethanol doses increased sharply and significantly. Females were not attacked more by untreated males in the same groups where treated males showed selective attack on females. These findings suggest that increasing levels of ethanol administration may produce changes in male rats' choices of targets for attack, with females becoming relatively more likely to be targets.

Ethanol Alcohol Offense Defense Aggression Attack-targets Colony formation

ETHANOL ingestion appears to considerably increase violent and aggressive behaviors in humans. A number of studies [10,15] have reported correlations between drinking and criminal violence. Family violence has also been linked to alcohol consumption, with consistent evidence that wife abuse is more common when husbands have been drinking [5, 13, 14].

Experimental tests in animals of the relationship between alcohol administration and agonistic behavior require models which provide detailed, validated measures of aggression. Tests differentiating offensive from defensive behaviors, often using a resident-intruder confrontation, or confrontations in a neutral arena have been used in a number of studies of the effects of ethanol on aggression in mice [3, 6, 8, 11] and rats [7,9]. These studies have been consistent in showing a decrease in aggression with higher levels of ethanol, but less consistent in showing heightened aggression with lower ethanol doses.

While such situations have the virtue of relative simplicity, and additionally permit measures which are ethologically relevant, they do not provide a range of social stimuli for analysis of potential differences in the targeting of attack following ethanol administration, or the effects of ethanol on the relationship between attack and sexual behaviors. These relationships can, however, be investigated in colony situations involving mixed-sex groups of animals.

The present study accordingly investigated the effects of different doses of ethanol given to a single male in 3 male, 3 female colonies, at the time of colony formation. "Formation fighting" is not contaminated by previous mutual social experience of the animals, and it provides a situation which produces relatively high levels of inter-male fighting in non-treated rats.

METHOD

Subjects

The subjects were 102 male and 102 female Long-Evans rats, from 133 to 167 days of age. Weight of the males varied from 357–507 grams, with an average of 437 grams. Male weights within each colony group varied less than 20 grams. These animals were socially reared in like-sexed groups of 3–4 from weaning until they were used in the experiment.

Apparatus

The colony enclosures were 90×70 cm metal pans with removable hardware cloth tops. Each colony contained wall-mounted water bottles, and food pellets were freely available. Interactions within the colonies were recorded on videotape using Panasonic PK 956 video cameras, and later

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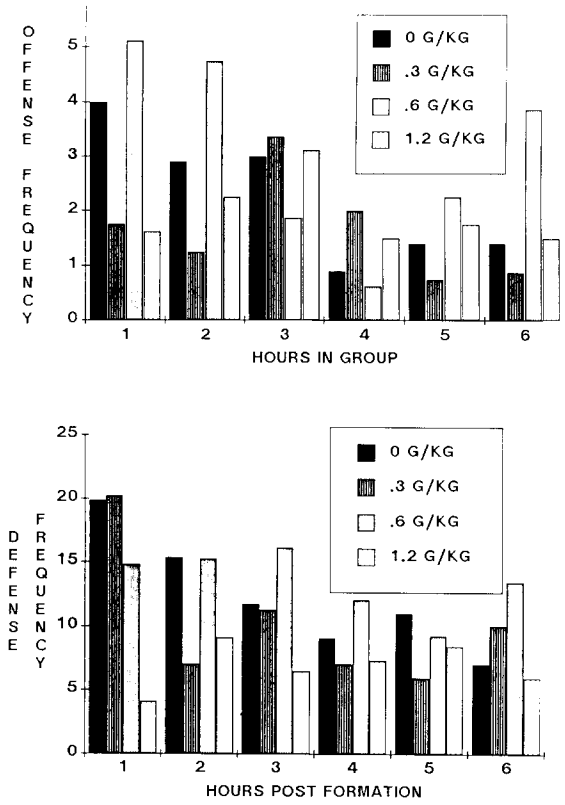

FIG. 1. (Top graph). Total offense (lateral attack, on-top-of, and chase) frequencies for the treated males of each group, by hours. (Bottom graph). Total defense (lying on the back and flight) frequencies for the treated males of each group, by hours.

scored by trained observers. Reliability tests made at intervals throughout scoring indicated a 90% or better agreement between raters on all behavior categories scored. All taping was done under red light. A digital time display was superimposed on the tape during recording.

Procedure

Each colony group consisted of 3 males and 3 females. Assignment to groups was random, except for the stipulation that males' weights within each group not vary by more than 20 grams. The 34 groups thus formed were randomly divided into four conditions. Saline was given to 1 male in each of 10 colony groups, while males in each of 8 groups were assigned to one of the 3 ethanol dose levels. These were 0.3, 0.6, or 1.2 g/kg body weight. The selected male from each group received its saline, or ethanol dose in an equal volume IP injection 20 minutes prior to colony formation.

At colony formation, all subjects of a group were placed into a colony enclosure. Subjects had been maintained under a 12:12 light-dark cycle and all colonies were formed at the beginning of the dark cycle. Videotapes of the behaviors of all subjects in the colony were made over the first 6 hours of colony formation.

Tape Scoring and Analysis

Incidence and duration of offensive, defensive, and boxing behaviors of each male toward each of the other animals

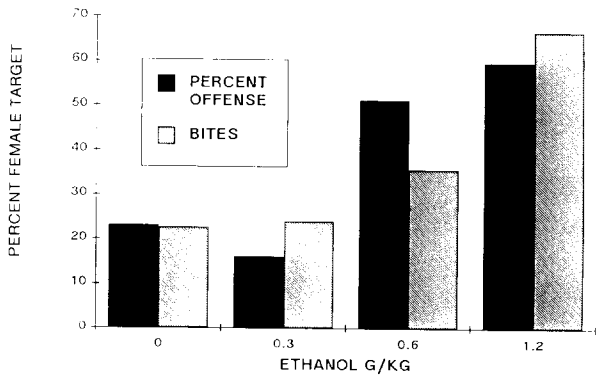

FIG. 2. Percentages of attack, or bites, directed at colony females by males given different doses of ethanol. Potential targets consisted of 2 males and 3 females per colony.

in the colony were scored by trained observers from the videotapes. Offensive behaviors measured were lateral attack, on-top-of, and chase. Defensive behaviors were lying on the back, and flight. Bites were also tabulated. For definitions of these behaviors see Blanchard, Blanchard, Takahashi and Kelley [1].

RESULTS

Offensive Behaviors and Related Measures

Figure 1 presents the total offensive behavior (lateral attack, on-top-of, and chase) frequency toward other colony members for the treated males of each group. As this figure suggests, offense frequency was highest for most groups during the first hour, tending to decline over the remaining 6 hours of testing. This temporal decline was statistically significant, $F(5,150)=3.04$, $p<0.05$. During the first hour, and in most hourly periods, offense scores for the saline-injected control group were higher than for the treated groups; however, the overall difference was not significant, $F(3,30)=0.76$, $p>0.05$. Since previous work [7] has shown a decline in offense at the 1.2 g/kg ethanol dose level, the difference between this group and the saline control was evaluated, and was found to be significant, $t(16)=2.77$, $p<0.02$, with males of the high ethanol dose condition showing reduced total offense.

Total defense for the treated males, also shown in Fig. 1, followed a similar pattern, with a tendency for lower levels of defense for the 1.2 ethanol group, especially during the first hour of testing. However, the overall test of differences among the groups was again not significant, $F(3,30)=0.75$, $p>0.05$. These data thus offer no suggestion that the defensive behaviors measured decline at dose levels which leave offensive behaviors intact.

Analysis of possible changes in the targets of attack by treated males involved calculation of the proportions of attack by these males directed at the three females of the group, compared to attacks on the two remaining (untreated) males. These are given in Fig. 2.

Males receiving saline or low ethanol (0.3 g/kg) doses directed about 15–25% of their attacks toward females, while the higher dose-level males made a majority of their attacks on the females of the group. These attack proportion differ-

TABLE 1

FREQUENCY OF OFFENSE (PER HOUR) BY UNTREATED MALES OF FOUR GROUPS

Group (g/kg ethanol)	Treated Males	Untreated Males	Females
0.0 (saline)	3.76	5.82	3.30
0.3	2.80	4.40	3.03
0.6	4.80	5.15	3.19
1.2	4.10	3.45	3.19

TABLE 2

MEAN NUMBER OF MOUNTS PER HOUR BY TREATED AND UNTREATED MALES OF THE FOUR GROUPS

Group(g/kgethanol)	Treated Males	Untreated Males
0.0 (saline)	5.27	7.37
0.3	10.21	11.10
0.6	3.75	4.60
1.2	4.79	5.59

ences were statistically significant, $F(3,30)=5.78$, $p<0.01$. Thus there appeared to be a shift in targeting of offensive acts, with increasing levels of ethanol. Some confirmation of this pattern may be found in the proportions of bites made by treated males on untreated males and on females, also shown in Fig. 2. While these were based on very few biting rats in the higher ethanol dose groups, and could not be meaningfully analyzed statistically, the bite proportions directed at females are similar to those for offense proportions by the same treated rats. This pattern of higher levels of offense and bites with ethanol administration also appeared in the first hour after testing: The saline group made 26%, the 0.3 g/kg group, 46%, the 0.6 g/kg group 39%, and the 1.2 g/kg group, 65%, attacks at female as opposed to male targets.

Another basis for analysis of this pattern may be seen in comparison of targeting of offense scores for the two untreated males for each group. Offense by untreated males toward the one treated male of each group, toward the other untreated male in the group, and toward group females is presented in Table 1. It is apparent from these data that the relative frequencies of untreated male offensive behaviors toward females remained quite constant, with about 20–30% of offensive acts being directed at the three group females, and between 70 and 80% directed at the two remaining group males. It is notable that the frequency of attacks on females obtained for the saline-injected males also fell within this range.

Differences in the frequency of attacks by untreated males directed at untreated vs. treated males for the four groups were not statistically significant, $F(3,64)=1.44$, $p>0.05$. In view of a recent report [9] of higher attack (combined attack and bite score) by untreated rats on male conspecifics receiving higher ethanol doses, we combined offense and bite scores for untreated males of Group 1.2, toward the one treated, or, the one remaining untreated, male of each colony. This comparison did not yield a significant difference, $t(14)=-0.29$, $p>0.05$, between the two target stimuli, with, in fact, slightly higher scores for attacks to the untreated males.

Frequency of mounts by the treated and untreated males of each group are presented in Table 2. These are of interest in terms of an hypothesis that the higher proportions of attacks on females by treated but not untreated males of the higher ethanol dose groups may be associated with systematic alterations of sexual behavior. This table suggests a substantially greater number of mounts for males of the 0.3 group, compared to all other groups. However, this apparent increase in mounting is seen in untreated as well as treated males, suggesting that something about this specific group, possibly the presence of an unusual number of receptive females, is responsible for the increase. Moreover, statistical analyses of these differences indicated that the ethanol dose effect on mounts for the treated and the untreated group failed to reach an acceptable level of statistical significance $F(3,30)=2.36$, and 1.72, respectively, $p>0.05$.

DISCUSSION

The primary purpose of this study was to investigate ethanol effects on agonistic behavior in a complex situation which involves inter- and intra-sex interactions. Each colony situation involves six animals, and it is clear [2] that the variation among laboratory rats, especially the males, can have a profound impact on the amount of fighting within a group, and the nature of the dominance system that arises as a result of agonistic interactions. Thus, the colony situation does involve considerable variability both among the males of a group and between groups.

This proved to be true in the present situation, in which ethanol was associated with a number of changes, often of considerable magnitude, which nevertheless were not statistically reliable. The previously reported decrement in offense at higher ethanol doses [7] was reliable for the first 2 hours of colony formation, but these data contain no suggestion of an increase in attack for treated males at low to intermediate doses. The defense data was consonant with previous findings [2] of a decrement only with the higher dose, while defense frequencies for the low dose (0.3 and 0.6) treated males were similar to those of the saline control. These findings lend no support to an interpretation that ethanol-related reductions in fear-related inhibition of fighting may be a factor in changes in overt aggression of rats under low ethanol doses. Since previous work [2] has suggested that one category of defensive behavior, defensive attack, may actually increase with low ethanol doses in wild rats, it should be noted that defensive attack reactions could not be meaningfully analyzed in this situation, and that the present total defense frequency measure includes only such activities as defensive sideways, boxing, on the back and flight.

The most intriguing finding of the present study was a consistent, and reliable, shift in the relative proportions of attack towards female, as opposed to male, targets, with intermediate and higher ethanol doses. The mount data are also relevant to this phenomenon, since a relationship between attempts to mount and attacks on females might be expected. However, since the treated males showing more than 50% female attacks (0.6 and 1.2 g/kg ethanol) failed to show any increase in mount frequencies, it seems unlikely that the differential magnitude of attack toward females in

these groups was a direct function of increased sexual activity for these animals. Additionally, the 0.3 group, in which treated males made about twice as many mounts as did the treated males of any other group, failed to show any increase in the relative proportions of attack toward females.

Although there is little direct evidence on differential targeting of attack by intoxicated, as opposed to nonintoxicated, men, the present finding that females are differentially targets of attack by male rats given intermediate or higher level doses of ethanol may have some human parallel: These data are in agreement with previous suggestions that many men who abuse their spouses when drinking, do not do so while sober [4]. They are also in general agreement with the finding that murder, nonnegligent homicide, and assault, crimes in which the perpetrator is more likely than not to be drinking [10], involve women much more often as victims than as perpetrators: while only 13.5% of arrestees for these crimes are women, 35.7% of the victims are women [12]. In this context it would clearly be of interest to determine if intoxicated males differently direct assault toward a woman victim, in comparison to males who are sober, and if so, to determine the mechanisms underlying this phenomenon.

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