Pharmacology Biochemistry & Behavior, Vol. 27, pp. 641–644. © Pergamon Journals Ltd., 1987. Printed in the U.S.A. 0091-3057/87 $3.00 + .00

Ethanol Effects on Aggression of Rats Selected for Different Levels of Aggressiveness[1]

ROBERT J. BLANCHARD, KEVIN HORI, D. CAROLINE BLANCHARD

Department of Psychology, University of Hawaii

AND

JAMES HALL

Alcohol Treatment Outpatient Clinic, Honolulu Veterans Administration, Honolulu, HI 96822

Received 1 December 1986

BLANCHARD, R. J., K. HORI, D. C. BLANCHARD AND J. HALL. *Ethanol effects on aggression of rats selected for different levels of aggressiveness.* PHARMACOL BIOCHEM BEHAV 27(4)641–644, 1987.—Male rats confronting strange male intruders into their home cages were divided into nonaggressive, low-to-intermediate aggressive, and highly aggressive groups. In tests with low (0.3 and 0.6 g/kg) doses of ethanol the nonaggressive rats did not become aggressive; low-intermediate animals showed a significant increase in frequency and duration of attack behaviors; but highly aggressive rats displayed a slight (nonsignificant) decline. A higher ethanol dose (1.2 g/kg) consistently led to decreased aggression. This rate-dependency of the enhancement of aggression by low doses of ethanol is concordant with a view that the mechanism of this enhancement involves ethanol interference with some mechanism which normally acts to limit or inhibit attack.

Ethanol Aggression Attack Attack inhibition Rate dependency

EXPERIMENTAL analyses of the effects of ethanol on aggressive behaviors of laboratory animals have provided a very complex and varied set of results (see [2] for review). While there is general agreement that higher ethanol doses, about 1.0 g/kg and above, decrease aggression, there is less agreement concerning the possible enhancement of aggression by lower doses of ethanol. While such an enhancement has been obtained in both mice and rats [8–10], it is not consistent, and may depend on specific characteristics of the test situation, the opponent, and indeed of the subject itself. Thus, the use of neutral arenas rather than the subjects' home cages for test encounters appears to facilitate the low-dose ethanol enhancement of aggression [10]; ethanol enhancement of female attack on an intruder male is stronger when the male is the same size as the female, rather than larger [4]; ethanol enhancement of attack may depend on the subject's normal level of aggression [8,9].

This last factor, that ethanol effects may depend on the rate of pre-ethanol attack or offense tendencies for the individual subject, is particularly interesting as it appears to have some parallel in human behavior: Aggressiveness following ethanol ingestion in humans appears to be relatively consistent within subjects and quite variable between subjects. Robbins [11] found that some human males are consistently nonaggressive when drinking, while others are consistently hostile, argumentative, or rowdy. Bailey [1] found that human males showing low levels of aggression before consuming alcohol showed an increase after drinking, while highly aggressive subjects tended to be unchanged after consuming alcohol. This was a subject, rather than a situational effect: Using the same task, Taylor [12] has consistently demonstrated that alcohol may interact positively with provocation or other situational attack potentiating factors. This possible similarity between human subjects, and laboratory rodents, that ethanol increases aggression primarily in low aggressive individuals, suggests that this phenomenon is one in which laboratory animals may provide an extremely useful model for experimental analysis.

METHOD

Subjects

Forty male Long-Evans rats, aged from 111 to 121 days served as subjects. These animals were maintained individually in standard 35×30 cm laboratory pan cages with ad lib access to food and water throughout the course of the tests. Three animals did not complete the series. The subjects were run in two replications.

Testing

Each animal was given two preliminary, 10-min tests involving a strange male intruder placed in its home cage. This provided some fighting experience to reduce the variability in attack associated with first encounters with a strange male conspecific [5].

[1]This research was supported by NIH grant AA06220.

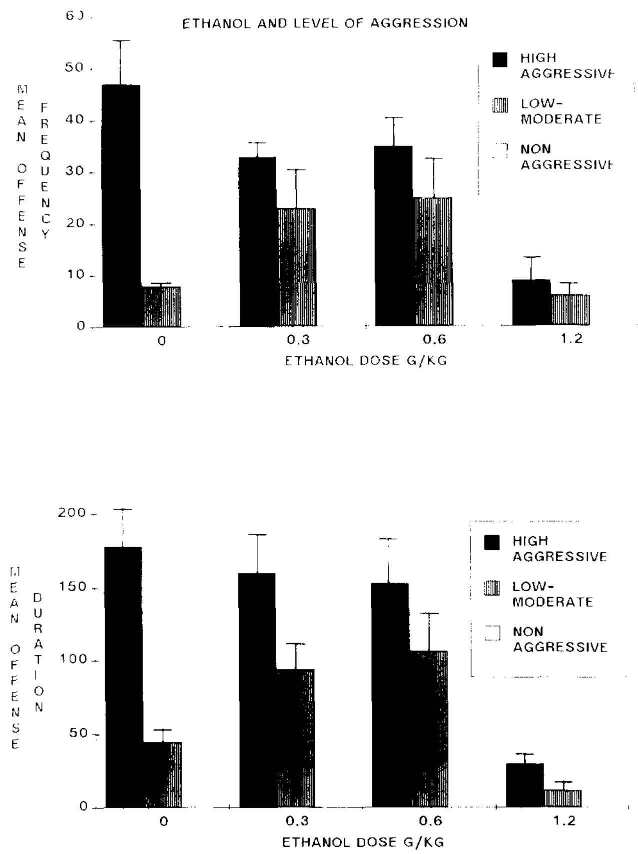

FIG. 1. Mean frequency (top graph) and duration (bottom graph) of three offensive behaviors, lateral attack, on-top-of, and chase, during 10-min test encounters with a strange intruder, for highly aggressive, low-to-intermediate aggressive and nonaggressive male residents under saline (0.0 g/kg), or 0.3, 0.6, or 1.2 g/kg ethanol. both frequency and duration of offense were at or close to zero for the nonaggressive group.

These were followed by four additional 10-min tests with a strange male placed into the subject's cage. Thirty min prior to the beginning of each of these tests, an equal volume IP injection of saline, 0.3, 0.6, or 1.2 g/kg ethanol was given to the subject. The order of the saline and ethanol doses was counterbalanced and tests were run 2 days apart. Video recordings were made of the test encounters, and frequencies and durations (where appropriate) of a number of the subjects' attack behaviors were scored from these tapes.

Three of these behaviors, lateral attack (subject's lowered head is oriented toward the intruder with back and hind legs arched; its body curves longitudinally toward, and moves laterally against, the opponent); on-top-of (subject stands over or on top of its supine opponent); and chase (subject runs after the fleeing opponent) were summed to produce a "combined offense" score for each animal at the different ethanol doses. These three behaviors all occur as initial components of the rat attack pattern, not directly harming the opponent, but enabling the attacker to position itself in order to bite effectively [3]. Bites, the terminal component of the attack pattern, were scored and analyzed separately. This grouping and analysis of scores was based on the results of a pilot study which suggested that the initial and terminal portions of the attack pattern are not well correlated in relatively inexperienced attackers, although the various initial components of the attack pattern do tend to occur together.

Based on the total frequency of offense during the saline test, subjects were divided into three groups: Those animals displaying more than 15 offensive behaviors (lateral attack, on-top-of chasing) during the 10-min test period formed the high aggression group; those displaying between 1 and 15 offensive behaviors became the low-to-intermediate aggression group, and those displaying no offensive behaviors were the zero aggression group.

Statistics

Differences between each subject's score during the saline test and tests made at each dose level were computed for subjects of the three groups. For the high and low-intermediate groups, difference scores for the combined offense measure, and the bite measure were subjected to a two-way analysis of variance, with initial level as a between subjects factor, and the different dose levels as within-subject factors.

RESULTS

Of the 37 subjects completing the series, 8 showed no aggression during the saline test and were classified as the zero aggression group. Of the remaining 29 subjects, 12 had offense frequency scores higher than 15 (range: 19 to 123), and constituted the high aggression group, while the remaining 17 displayed 1 to 15 offensive behaviors during the saline test and were placed into the low-intermediate aggression group.

The zero aggression group could not, of course, show decrements from the saline condition to the various dose levels, but it is of interest to note that they did not show increases either: Only 3 of the 8 animals in this group showed any offensive behaviors during any test. All of these were at the 0.3 g/kg ethanol level and involved brief chasing of the intruder. Because these data, with 21 of 24 scores at zero, clearly did not meet the assumptions necessary for parametric analysis, they were not directly compared to those of the high and low-intermediate groups in the following analyses.

Figure 1 presents differences between the frequency of offense during the saline test, and, at the 0.3, 0.6, and 1.2 g/kg ethanol doses for subjects of the high, and low-intermediate, aggression-level groups. As this figure suggests, the patterns of change across dose level tended to be very different for animals showing high, as opposed to low-intermediate levels of offense during the saline tests. At each dose level the high aggressive groups' scores decreased substantially, while those of the low-intermediate aggressive group increased at both the 0.3 and the 0.6 levels, declining to slightly below the base level at the 1.2 dose. Change scores (subject score at a given level minus subject score under saline) at the different levels were significantly different for the two groups, $F(1,27)=23.50$, $p<0.001$. The main effect of alcohol was also statistically significant, $F(2,54)=11.76$, $p<0.001$. The interaction of group and dose level was not significant, $F(2,54)=0.17$, $p>0.05$.

Individual *t*s for correlated measures were used to test differences between the saline, and 0.3 and 0.6 dose levels, for the high and low-intermediate groups. For the high aggressive group, frequency of offense declined for all ethanol doses. For the 0.3 and 0.6 levels this decrease approached, but failed to reach, an acceptable level of statistical significance, $t(11)=2.10$ for the 0–0.3 dose level comparison, and 1.83

for the 0–0.6 dose level comparison, $0.10<p>0.05$ for each. Wilcoxon Ts were used to test the significance of differences between the saline and 1.2 dose level, because of the high proportion of zero scores at 1.2 g/kg ethanol. The decline seen at the 1.2 dose level was statistically significant, $T(12)=0$, $p<0.001$.

For the low-intermediate aggression group, the increases seen in frequency of offense at the 0.3 and 0.6 dose levels were both statistically significant, $t(16)=2.40$ and 2.22, respectively, $p<0.05$ for each. The decline seen at 1.2 g/kg ethanol was also significant, Wilcoxon $T(17)=31.5$, $p<0.05$.

Duration of offense presented a very similar pattern to the frequency of offense data. These data are also presented in Fig. 1. Analysis of variance on the change scores indicated that the group difference was significant, $F(1,27)=11.99$, $p<0.001$, as was the dose level effect, $F(2,54)=14.08$. As with the frequency of offense, the interaction of group and dose level was not significant, $F(2,54)=0.25$, $p>0.05$. Subsequent ts indicated that the decreases in duration of offense for the high aggressive group at the 0.3 and 0.6 dose levels were not significant, $t(11)=0.71$ and 0.88, respectively, $p>0.05$, but that the decline seen with the 1.2 g/kg dose was significant, $T(12)=0$, $p<0.001$. For the low-intermediate aggressive group, the increases seen at the 0.3 and the 0.6 dose levels were statistically significant, $t(16)=2.22$ and 2.54, respectively, $p<0.05$ for each. The decline seen for this group at the 1.2 dose level was also significant, Wilcoxon $T(17)=27$, $p<0.01$.

The bite frequency data was very similar to the pattern obtained with the combined offense measure; there was an increase, though considerably smaller than with the combined offense measure, for the low-intermediate aggression group, and a decrease for the high aggression group, at 0.3 and 0.6 doses, with both groups showing a substantial decline at the 1.2 g/kg dose level. For the bite frequency data, however, only the main effect of ethanol was significant, $F(2,54)=15.51$, $p<0.001$. The group effect was not significant, $F(1,27)=1.04$, $p>0.05$, nor was the interaction of group and dose level, $F(2,54)=0.40$, $p>0.05$.

DISCUSSION

The findings of the present study appear to be relatively straightforward on a descriptive level. Low doses of ethanol differentially affect the aggression of rats selected on the basis of initial aggression levels, somewhat reducing those of highly aggressive males, increasing attack in males with a low to intermediate level of initial aggression, but having no detectable effect (i.e., producing no increase) for those initially displaying no aggression.

While these data are in general agreement with other studies of ethanol effects on animals with varying attack tendencies, specific correspondences between the earlier findings and those of the present study are more difficult to establish: Miczek and Barry [9] used a more elaborate attack-training test, and dominant-subordinate, or dominant-naive pairs, with one animal of each pair receiving ethanol. The dominant animals showed a significant increase in frequency of biting attacks, and duration of "aggressive postures" at the 0.5 g/kg dose level. The Krsiak [8] study using mice, found a low dose enhancement in aggressive mice (level of aggression not specified) with a somewhat higher dose of ethanol enhancing attack in timid mice. The latter, however, had shown low levels of chasing and other attack-related behaviors under saline and thus would better correspond to the present "low-intermediate" aggression group, than to the nonaggressive group. A "sociable" group showing no initial aggression failed to demonstrate increased aggression with ethanol.

These studies are thus consistent in suggesting that low doses of ethanol do promote attack in at least some animals showing attack before ethanol was given. The present study is consonant with this view, but adds to it, suggesting that only the low to intermediate aggressive animals show this effect. Alternatively, since both of the earlier studies involved tests in a neutral arena, while the present tests were in the subjects' home cages, it is possible that the present conditions were less optimal for the ethanol enhancement effect [2]. If this less optimal test situation contributed to a decline in attack for the high attacking rats, it might have sharpened the differences of the two groups, with one showing a rise, and the other, a drop, under low ethanol doses. However, in the absence of any reason to believe that the home cage vs. neutral arena variable differentially influenced the two groups, the present finding of a substantial difference in change scores for rats differing in initial attack tendencies should also hold for the neutral arena situation, although an actual decline (which was here nonsignificant as well) for the high attacking group might not be apparent.

The Krsiak [8] study is consistent also with the present findings in suggesting that low doses of ethanol are ineffective in promoting attack in initial nonattackers. DeBold and Miczek [7] have recently reported that castrated male mice not receiving testosterone replacement also fail to show an ethanol enhancement of attack, while castrates receiving high levels of testosterone show a very pronounced ethanol enhancement, even at ethanol levels which decrease attack in intact mice. This suggests that some male rodents showing no attack tendencies under saline may be relatively deficient in testosterone, a possibility which is consonant with an unpublished finding from this laboratory, that male rats selected on the basis of nonaggressiveness show much lower rates of successful breeding than do aggressive males. Whether testosterone is a mediating factor or not, it seems likely that animals showing no aggression in a rather effective aggression-eliciting procedure such as was used in the present study do have some deficiency in the process or system leading normally to attack in male rats. This finding is consonant with the principle that drugs do not create behavior though they may act to alter strength or probability of ongoing behavior processes.

In fact, the results of all three of the present groups are consonant with a view that ethanol enhancement of attack is mediated, not by a direct enhancement of attack tendencies, but by interference with an inhibition system which is irrelevant in the nonaggressive rats, but acts to suppress aggression in the low aggressive animals: It might reasonably be assumed that this putative aggression-inhibiting factor was minimally effective in the highly aggressive animals.

The present results, then, suggest that the procedure of dividing animals with equivalent aggressive experience into highly aggressive, low-to-intermediate aggressive, and nonaggressive groups may provide a robust differentiation of some factor or factors mediating the effects of low doses of ethanol on attack behaviors. If so, then this procedure may provide a valuable tool for analyses leading to identification and characterization of the factors involved in the effects of ethanol on aggression.

REFERENCES

1. Bailey, L. *Differential Effects of Alcohol Consumption on Aggression in a Reaction Time Competition Task for High and Low Aggressive Subjects*. Unpublished Master's Thesis, Kent State University, Kent, OH, 1982.
2. Berry, M. S. and R. Smoothy. A critical evaluation of claimed relationships between alcohol intake and aggression in infrahuman animals. In: *Alcohol and Aggression*, edited by P. Brain. Beckinham: Croon Helm, 1986.
3. Blanchard, R. J. and D. C. Blanchard. The organization and modelling of aggressive behavior. In: *The Biology of Aggression*, edited by P. F. Brain and D. Benton. Alphen aan den Rijn: Noordhoof/Sijthoff, 1980.
4. Blanchard, D. C., K. J. Flannelly, K. Hori, R. J. Blanchard and J. Hall. Ethanol effects on female aggression vary with opponent size and time within session. *Pharmacol Biochem Behav* **27:** 645–648, 1987.
5. Blanchard, R. J., L. K. Takahashi and D. C. Blanchard. The development of intruder attack in colonies of laboratory rats. *Anim Learn Behav* **5:** 365–369, 1977.
6. Blanchard, R. J., D. C. Blanchard, T. Takahashi and M. Kelley. Attack and defensive behaviour in the albino rat. *Anim Behav* **25:** 622–634, 1977.
7. DeBold, J. F. and K. A. Miczek. Testosterone modulates the effects of ethanol on male mouse aggression. *Psychopharmacology (Berlin)* **86:** 286–290, 1985.
8. Krsiak, M. Effect of ethanol on aggression and timidity in mice. *Psychopharmacology (Berlin)* **52:** 75–80, 1976.
9. Miczek, K. A. and H. Barry, III. Effects of alcohol on attack and defensive-submissive reactions in rats. *Psychopharmacology (Berlin)* **52:** 231–237, 1977.
10. Miczek, K. A. and J. M. O'Donnell. Alcohol and chlordiazepoxide increase suppressed aggression in mice. *Psychopharmacology (Berlin)* **69:** 39–44, 1980.
11. Robbins, R. Alcohol and the identity struggle. Some effects of economic change on interpersonal relations. In: *Beliefs, Behaviors, and Alcoholic Beverages: A Cross-Cultural Survey*, edited by M. Marshall. Ann Arbor: University of Michigan Press, 1979.
12. Taylor, S. P. The regulation of aggressive behavior. In: *Advances in the Study of Aggression, Vol 2*, edited by R. J. Blanchard and D. C. Blanchard. Orlando: Academic Press, 1986.