Technical Papers

Intensity of White Noise and Frequency of Convulsive Reactions in DBA/1 Mice

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The bell-tub method devised by Hall (*1*) for inducing audiogenic seizures in mice involves stimulating mice placed in an ordinary washtub for a period of 90 to 120 sec with noise produced by the ringing of an electric doorbell over the tub. Although this method has been widely used in studies of audiogenic seizures during the past 6 yr, relationships that may exist between variable aspects of the stimulus used in the method and incidence of seizures have not yet been systematically studied. That the intensity of the stimulus is an important factor governing occurrence of audiogenic seizures in mice has already been shown by Frings and Frings (*2*) who found a probable sigmoid relationship between intensity of a pure 10-kc/sec tone and incidence of seizures in mongrel albino mice. The present study (*3*) was designed to obtain further information concerning the relationship between stimulus intensity and seizure incidence in the more genetically homogeneous DBA strain of mice in a situation employing a stimulus similar in complexity to that used in the bell-tub method.

Control over the stimulus and a wide intensity range were obtained by using an H. H. Scott Noise Generator, Type 810-A. The output of the noise generator, which consisted of white noise over the range of 2 to 15 kc/sec according to information supplied by the manufacturer, was amplified with a Lafayette Model 2N189 amplifier. Amplifier controls were set for maximum attenuation of low frequencies to protect the reproducer, a University, Model M1DT, high-frequency loudspeaker. The loudspeaker was suspended with rubber bands directly over a 4-in. square, 6-in. high, clear plastic test cage. Eleven equally spaced ⅛ in. round brass rods formed the top of the cage. This small open-bottom cage was placed on a clean sheet of paper within a larger, partially soundproofed compartment, which was 14 in. deep, 16 in. wide, and 22 in. high, and had a clear glass front. A door, 16 in. wide and 6 in. high, below the glass front permitted access to the interior of the larger compartment.

A total of 80 mice, 40 males and 40 females, of the DBA/1 strain were used as subjects. Mice 30 to 34 days old were chosen, since Vicari (*4*) has shown that mice of the related DBA/2 strain are maximally susceptible to seizures at this age. The mice were randomly assorted into four experimental groups, each composed of 10 males and 10 females as a control for the slight sex difference in seizure susceptibility that has been noted in this strain.

The procedure was similar to that described by Vicari (*4*). Each mouse was carried by the tail from an outside room to the room containing the apparatus. The mouse was then placed under the small test cage inside the larger compartment. After a 10-sec adaptation period, a switch was thrown to connect the loudspeaker to the amplifier. Stimulation was continued for 90 sec or until death of the subject. Each mouse was tested only once.

Four levels of white noise intensity at the floor of the small test cage were used, respectively, with the four experimental groups: 110, 115, 120, and 130 db above 0.0002 dynes/cm^2 rms pressure. In setting sound pressures at these levels, an H. H. Scott Sound Level Meter, Type 410A, was used with the microphone placed on the floor within the test cage. Momentary variations of ±1 db from each of the four levels occurred frequently. The range of variation of sound pressures from the center to peripheral points of the test-cage floor could not be measured accurately, owing to the large diameter of the microphone. Maximal peripheral displacement of the microphone produced no noticeable change in sound-pressure readings. At the top of the test cage, sound-pressure readings were 3 to 4 db above floor-level readings, momentary variations remaining ±1 db.

Since a small test cage was used to minimize variations in stimulus intensity, the typical preseizural wild running of the subject that is elicited with the bell-tub method could not occur. Instead, preseizural behavior took the form of wild jumping. The criterion assumed in recording wild jumping was two or more jumps in rapid succession. Latencies of the convulsive reactions that occurred were measured with a stop watch from the onset of sound to the instant when the mouse fell over on its side. The results are summarized in Table 1.

In every instance when fatal or nonfatal convulsions occurred, wild jumping preceded the convulsions by a few seconds. The mean latencies of the convulsive reactions that did occur were 37.0, 38.0 and 34.2 sec, respectively, for mice in the 115-, 120-, and 130-db groups. Latencies ranged between 9.6 and 51.9 sec, both of these extremes occurring in the 130-db group. Since mean latencies are based on such small numbers, they are not regarded as reliable enough to indicate any trend.

When the percentages of fatal and nonfatal convulsions shown in Table 1 are totaled and plotted

Table 1. Percentage incidence of fatal and nonfatal convulsions and wild jumping reactions in groups of 20 DBA/1 mice 30 to 34 days old under four levels of white noise intensity.

Reaction	Sound pressure (db)			
	110	115	120	130
Fatal convulsion	0	10	25	30
Nonfatal convulsion	0	0	10	15
Wild jumping	35	65	75	95

against respective sound-pressure levels, a sigmoid function is strongly indicated. This conforms with the previous finding of Frings and Frings (*2*) of a sigmoid relationship between seizure incidence and intensity of a pure tone. A monotonic, negatively accelerated function is suggested when percentages of wild jumping reactions are plotted against sound-pressure levels. Chi-square tests show that the 110- and 130-db groups differ significantly at the 0.02 level or better with respect to frequencies of fatal convulsions, fatal and nonfatal convulsions together, and wild jumping reactions. Clearly, incidence of audiogenic reactions in DBA/1 mice is directly related to intensity of stimulation with white noise.

A final observation of interest is that none of the mice convulsed at 110 db in the present situation, although very high frequencies of seizures are obtained with sound pressures between 80 and 90 db with the bell-tub method (*4*). This is most probably due to differences in the frequency components of the stimuli used in the present study and in bell-tub experiments. One complex sound is not necessarily as effective as another complex sound, even though both have the same intensity.

References and Notes

1. C. S. Hall, *J. Heredity* **38**, 3 (1947).
2. H. and M. Frings, *J. Acoust. Soc. Amer.* **24**, 163 (1952).
3. This work, performed under the Summer Research Program of the Roscoe B. Jackson Memorial Laboratory, was made possible by a grant to the Laboratory from the Carnegie Corporation of New York. I am indebted to J. L. Fuller and Mary E. Smith of the Jackson Laboratory for provision of the apparatus used and for technical assistance. Suggestions made by Dr. Fuller and R. M. Chambers of the Jackson Laboratory and B. E. Ginsburg of the University of Chicago have been of great value in the preparation of this report.
4. E. M. Vicari, *J. Psychol.* **32**, 79 (1951).

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Social Aggressiveness in an Amphibian

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Problems of aggression have long occupied man, and they still appear to be in the forefront of importance. As one aspect of the total picture, the phenomenon of territoriality has attracted a large measure of interest from biologists in recent years, ever since it was effectively described by Howard (*1*) in birds. More recently, various workers have provided information on the extensiveness of territoriality, discussed the variations in its manifestation, indicated some of its functions, and refined our concept of it. Its significance as a feature of social behavior, as a regulator of population density, as an evolutionary factor operating in selection and in gene spread, and as a factor in promoting social well-being in various ways have all been shown or suggested by these investigations. Even so, much remains to be learned about it.

By territoriality is meant the defense of an area from invasion by another of the same species. This concept seems to be the most useful one and is generally accepted by workers in touch with its study. That some of the earlier, more restricted definitions are not adequate in the light of more recently gained information has been pointed out by several people over a period of years, as reviewed by Nice (*2*). Territoriality and the related phenomenon of maintenance of a home range were clearly separated by Burt (*3*), and their significant differences seem to allow no further confusion of the terms.

Among nonhuman animals, territoriality has been most intensively, as well as extensively, studied in birds, partly because of the ease of observation. However, it is known to be exhibited also by some species in other groups of animals—invertebrates, fish, reptiles, and mammals (*4*). To my knowledge, there had been no reported evidence of its occurrence in amphibians until Martof's suggestion (*4*) that a weakly developed sort of territoriality is exhibited by calling males of the frog *Rana clamitans* in breeding groups. The principal purpose of this paper is to report that a well-developed, aggressive territoriality is clearly demonstrated by the nonarboreal South American frog, *Phyllobates trinitatis* Boulenger. In the coastal mountains of northern Venezuela, this frog is common in the small streams about the Venezuelan Estación Biologica de Rancho Grande, near Maracay. Here, I observed it from Sept. 1951 to Jan. 1952 (*5*).

Territorialism was most frequently seen in adult females, which reach 28 mm in head-body length. They are a little larger than males and more brightly colored. The females have stations along the edges of streams, where each feeds in the daytime in a limited area, its home range, and seeks shelter, when alarmed, in a small opening beneath the rocks. Most of the home range, including the shelter site, is maintained as a territory from which the resident frog attempts to drive off intruders of the same species, usually with success.

The first aggressive act by the resident is usually a hopping approach to the intruder and a challenge, in which the bright yellow throat is exhibited and slowly pulsated. If the intruder does not retreat, the resident female makes a quick jump over the intervening few inchs and alights directly on the other animal, uusually on its back or head. In most instances, this is sufficient stimulus to cause the attacked frog to jump away, but sometimes the intruder will stand her ground, even to the point of defending herself. Then ensues an actual wrestling bout of several seconds, until one of the pair retreats or is pushed off the rock on which encounters often take place.

Only rarely was territorial defense identified in an adult male, but it was found to be carried out by young frogs, even by some that had only recently metamorphosed. The phenomenon was not associated with breeding or with the site of egg-deposition. Rather, it was a defense of feeding grounds and shelter (home) site. It was not a rare occurrence but