Sexual Behavior: Stimulation by Painful Electrical Shock to Skin in Male Rats

Abstract. *A mildly painful electric shock lasting 0.5 second was delivered every 30 seconds to the skin of male rats while they were with a receptive female rat. Sexual behavior occurred, with brief latency, after shocks; thus, successive shocks resulted in a pacing of sexual behavior. This effect is attributed to periodic augmentation of sexual arousal by a periodic, nonspecific arousing stimulus (that is, shock).*

Copulatory behavior in rats and other rodents consists of a periodic sequence of mount bouts (*1*) at fairly regular intervals until ejaculation occurs (*2, 3*). Since nonspecific stimulation of an animal can augment the amount of sex behavior exhibited (*4*) we questioned whether the temporal patterning of copulatory behavior could reliably be brought under the control of a nonsexual arousing stimulus. We found that stimulus control of the timing of copulatory behavior can be achieved by administering mildly painful electric shock to the skin of male rats.

Six male albino rats, approximately 9 months of age, served as subjects. Selection was based on meeting an arbitrary criterion of four ejaculations in prior tests with sexually receptive females.

Test cages were 18-inch (46 cm) cubes with Plexiglas sides and steel mesh floors. Shocks were delivered through electrodes (common safety pins) placed in the skin toward the rear of the back, about 4 to 6 cm apart, and dorsal to the flanks. Ordinary 110-volt a-c line current which was passed through a variable transformer (Powerstat) and a step-down transformer produced a shock of 0.1 to 1.0 ma at 1 to 2 volts (root mean square). Delivery of the shock and its duration were controlled by automatic timers. Shocks were recorded automatically, and observed behavior was recorded manually, on an Esterline Angus event recorder.

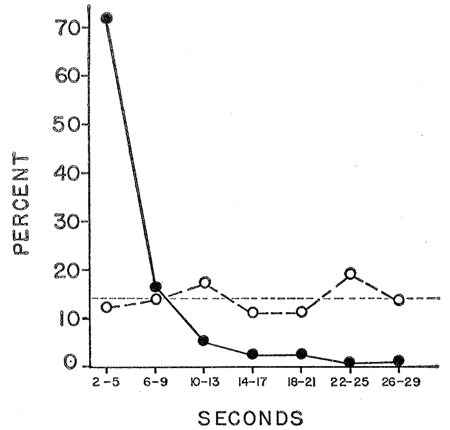

Fig. 1. Frequency distribution of latencies from shock to the execution of mount-thrust or intromission during the first two ejaculatory sequences. The shock condition is represented by solid circles and lines ($N = 211$). The open circles and broken line represent intervals between timer clicks and mating in the control tests ($N = 103$). The dashed line at 14.3 percent indicates the distribution of intervals expected if timer noise were having no effect on occurrence of mating. The maximum latency (or interval) possible is 29 seconds; the minimum is considered 2 seconds.

Each male was given two experimental tests (with shock) and two control tests (without shock). Control and experimental tests were given on alternate weeks; the first test was without shock in all cases.

Testing with a sexually receptive female continued at least until the first intromission after the second ejaculation. Before being tested with shock, the subjects were placed into the test cage, and the level of shock was established by finding an intensity which would cause the animal to jump slightly and to emit a small squeal. The rat was left alone for 5 minutes, and then a receptive female was placed into the cage; the shocks began 15 seconds later. Shocks lasting 0.5 second were delivered automatically every 30 seconds for the remainder of the test. Control tests were conducted in identical fashion; that is, the electrodes were attached and the timers made their customary noises every 30 seconds, but no shock was delivered.

Shocking resulted in a pacing of the rat's sexual behavior. In reaction to the shock, the animals usually jumped slightly, squealed, looked about, and then approached and mounted the female. Figure 1 shows that 72 percent of the copulatory responses occurred within 5 seconds of the shock, and the median latency between shock and mount was only 4 seconds. Naturally, movement toward or chasing the female began even sooner. Fewer than 10 percent of the shocks delivered during an ejaculatory sequence were *not* followed by copulatory activity. Even in these latter cases, approach and sniffing of the female usually occurred immediately after the male received the shock. In the control condition, males did not heed the click of the timer, and the occurrence of copulation was completely independent of it, as shown by the control data in Fig. 1. (There are fewer control points because, during the first series of control tests, timer clicks were not recorded.)

The effect of shock on temporal patterning of sexual behavior is shown in Fig. 2. There was a substantial peak of intervals between mount bouts around 30 seconds, and a secondary peak occurred at 60 seconds (that is, animals that failed to respond to one shock responded to the next). In control tests, the intervals between mount bouts were relatively large and highly variable, and there was no tendency for intervals to fall about 30, 60, or 90 seconds as would be expected if the timer noise had served as a cue. The administration of shock significantly reduced the intervals between mount bouts. There was no overlap between means of control and experimental tests; likewise the variability was substantially reduced ($F = 11.03$; d.f., 11,11; $P<0.001$).

After a rat ejaculates it becomes inactive, often sleeps, and shows no sexual activity. Only after 5 to 8 minutes or

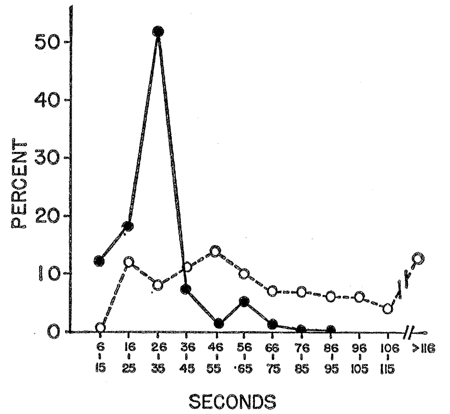

Fig. 2. Frequency distribution of intervals between mount bouts. The shock condition is represented by solid circles and line ($N = 234$) and the control by open circles and broken line ($N = 194$). Points on abscissa indicate length of intervals in terms of consecutive 10-second blocks. Intervals greater than 116 range up to 256 seconds in the controls. No experimental intervals exceeded 90 seconds. These data incorporate all intervals recorded in all tests during the first two ejaculatory sequences.

longer does the rat show renewed interest in the female and begin another copulatory sequence. In the experimental tests shock was automatically continued after ejaculation, and successive shocks usually resulted in a progressive increase in sexual arousal. For example, with consecutive shocks a male might turn toward the female, approach her, mount without thrusting, mount with thrusting but without intromission, and finally mount with intromission beginning a new ejaculatory sequence. The mean duration of the postejaculatory interval (measured from the preceding ejaculation to the first intromission of the next sequence) was reduced by 25 percent during the experimental treatment ($F = 30.2$; d.f., 1,47; $P < .001$). This effect is indicative of the arousing nature of the shock that was qualitatively apparent to the observers. It was also observed a number of times that administration of shock would cause the animals to mount the females when they would no longer do so spontaneously.

Our data have shown that a mildly painful shock to the skin can serve as a powerful entraining stimulus for the sexual behavior of male rats. The location of the stimulation makes interpretation of the data in terms of specific sexual motivation improbable. Rather, these results may be explicable in terms of fluctuations in arousal, and the effects of augmentation of arousal on sexual behavior.

In an attempt to inhibit mating tendencies of male rats, Beach *et al.* (*5*) administered shocks to animals during copulation and found that, while high levels of shock did inhibit the males, low levels actually enhanced their performance. They suggested that the excitement from the shock summated with sexual stimulation to influence sexual arousal, and our work can be interpreted in a similar way. That is, the stimulation of mounting can be attributed to the increase in arousal caused by the shock.

A role for general arousal in influencing sexual behavior has been suggested by augmentation of copulatory activity resulting from handling (*4*) or from administration of stimulating drugs such as amphetamine (*6*). Although a diversity of factors (*7*) may influence the rate or amount of sexual behavior, the degree of temporal control over mating behavior, achieved in our experiment by peripheral stimulation, has previously been reported only in studies in which intracranial stimulation was used (*8*).

According to Beach *et al.* (*5*) and our data, arousal induced by a mildly painful electric shock can effectively augment sexual behavior. Therefore, the conclusion of Ulrich and Azrin (*9*), that pain interferes with sexual behavior, must be qualified by a statement of which conditions cause pain-induced aggression and which cause pain-induced copulation. Apparently pain is not a sufficient condition for aggression. Obviously, the effect of shock depends upon its intensity and other variables such as whether a male or receptive female is present, and on the sexual and aggressive experience of the subject.

Our results stress the need for caution in the interpretation of studies involving the elicitation of specific behavior patterns by any intervention which could be a nonspecific arousing stimulus in a milieu in which the appearance of a particular behavior pattern is most highly probable.

RONALD J. BARFIELD*
BENJAMIN D. SACHS†
Institute of Animal Behavior,
Rutgers University,
Newark, New Jersey

References and Notes

1. A mount here refers to mounting with pelvic thrusts but without penile insertion. Intromission is a mount-thrust with insertion. A mount bout usually terminates after one to three mounts and is followed by a period of sexual inactivity. Intromission is considered to terminate a mount bout, since a similar period of quiescence characteristically follows. We refer to all bouts as mount bouts regardless of whether or not intromission occurs. Intervals between mount bouts are the times between the first mounts of successive mount bouts in an ejaculatory sequence; the latter is defined as a sequence of mount bouts that culminates in ejaculation.
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* Present address: Department of Biological Sciences, Douglass College, Rutgers University, New Brunswick, N.J.

† Present address: Department of Psychology, University of Connecticut, Storrs.

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Neural Processing of Backwards-Speech Sounds

Abstract. *When sounds such as those produced by reverse playback of recorded speech are presented to left and right ears of normal subjects, the sounds arriving at the right ear are more accurately identified than those arriving at the left. These findings are comparable to the right-ear superiority demonstrated with normal speech sounds, and contrast with the left-ear superiority for musical and other non-speech sounds. It is suggested that the neural mechanisms underlying the perception of speech and non-speech sounds are not differentiated along the dimension of conceptual content.*

The perception of verbal material is known to be mediated primarily by the left half of the brain in man. Previous studies have indicated that the dominance of the left hemisphere for perception of speech can be detected in normal persons by the more accurate report of verbal stimuli presented to the right (contralateral) ear compared with the left (*1*). In contrast, melodic patterns are more accurately identified when they are presented to the left ear (*2*); this fact reflects the known predominance of the right hemisphere in the processing of nonverbal sounds (*3*).

These auditory asymmetries appear to occur only with dichotic presentation: that is, with different sounds presented to the two ears simultaneously —not with monaural stimulation. They are not due to differences in acuity of the two ears, but rather to the advantageous neural connections of each ear with the opposite cerebral hemisphere. The probable neuroanatomical mechanism for asymmetry with dichotic presentation has been described (*4*).

The right-ear superiority has been demonstrated for digits, words, and nonsense syllables (*4*); left-ear superiority, for both familiar and unfamiliar melodic patterns (*4*) as well as for environmental non-speech sounds (*5*). All these results are consistent with the demonstrated division of labor between the left and right hemispheres in the processing of speech and non-speech stimuli, respectively (*6*).

The technique of dichotic presentation is thus demonstrably sensitive to the differential neural processing of verbal and nonverbal stimuli in the two hemispheres of the brain. Varying