

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.

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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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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

the stimulus characteristics of dichotically presented sounds should then enable us to form some conclusions regarding the factors involved in this differential processing.

Backwards-speech sounds were presented dichotically with the aim of discovering whether such highly unfamiliar, meaningless sounds would be processed in the same way as other speech sounds; that is, whether there would be more accurate perception of those sounds arriving at the right ear. The backwards speech was obtained by recording trisyllabic nonsense words on a half-track, dual-channel tape recorder, and then inverting the tape and playing it back in the normal direction. The result is something quite unusual and unfamiliar, somewhat resembling a Slavic language.

The subjects were 14 female and 10 male undergraduates in psychology; all were right-handed and had no known hearing defects.

On each trial the subject was first presented with two different backwards-speech sounds simultaneously: one to the left ear and one to the right. After a 4-second interval, four more backwards-speech sounds were played one at a time, two of them being identical with those played dichotically. The subject's task was to identify which two of the four he had heard presented dichotically. Each of the four positions of the sequence was used equally often for each ear. There were 12 trials, yielding a maximum possible score of 12 for each ear. For half the subjects the earphones were reversed from normal so that any asymmetry in the tape or apparatus was counterbalanced over ears.

This multiple-choice recognition procedure is identical with that used for melodic patterns, for which it yields a left-ear superiority (2), and for trisyllabic nonsense speech for which it yields a right-ear superiority (4). The backwards-speech sounds were never referred to as speech, but as "nonsense sounds."

The mean score for the left ear was 4.6 or 38-percent correct (S.D., 2.1); for the right ear, 7.6 or 63-percent correct (S.D., 2.8). The difference between ears is significant beyond the .001 level (t , 4.05; correlated means). Eighteen subjects showed right-ear superiority, four showed left-ear superiority, and two showed no difference between ears. Table 1 compares these data with data from the earlier study (4) employing normal nonsense speech.

Table 1. Comparison of left and right ears for trisyllabic nonsense speech under two conditions—forwards and backwards.

Left	Right	P
	<i>Forwards</i>	
5.6 (47%)	8.1 (68%)	<.01
	<i>Backwards</i>	
4.6 (38%)	7.6 (63%)	<.001

The right-ear superiority for backwards-speech sounds indicates that they are processed by neuropsychological systems overlapping those for normal speech sounds, rather than by systems for non-speech sounds; it provides strong support for the suggestion that the critical distinguishing characteristics of speech sounds are not related to meaningfulness, familiarity, or conceptual content (4). In a consideration of the acoustic characteristics to which the speech-processing system may selectively respond, Liberman *et al.* (7) have proposed that the auditory signals are perceived via the same motor-command signals as those responsible for producing speech. This suggestion implies that only sounds that can be articulated should be processed by the speech system. Our intention in making backwards-speech stimuli was to have inarticulable sounds, but in this we were only partly successful. Although these stimuli are extremely difficult to reproduce, the subjective impression when one tries to hold them in storage for the few seconds until they are identified is that one is treating them as though they were sounds that one could produce. Several spontaneous reports of this kind came from the subjects also. Thus we may not have ruled out the participation of some kind of articulatory mechanism during the "holding" period.

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Frog Germ Cells

In describing an experimental refutation of the hypothesis that amphibian germ cells might be carried to the gonads in the circulatory system, Volpe and Curtis (1) appear to be unaware both of the improbability of their hypothesis and of apparently contradictory results.

The movements of primordial germ cells have been traced in a variety of Anura (2). After a probably passive displacement during gastrulation, the germ cells are detected in successively more dorsal regions of the trunk endoderm and remain in the mesentery as the dorsal crest of the endoderm is withdrawn. This is presumably an active migration, occurring mainly within the endoderm and before the onset of the blood circulation. Little further migration would be required for the germ cells to reach the adjacent genital ridges.

Despite this, the technique of parabiosis can result in one gonad containing germ cells from both "siamese twins." Using genotypes marked by the presence or absence of nucleoli in *Xenopus*, I obtained such chimeras in seven of the eight twins analyzed (3). Minor differences in technique may account for the discrepancy of our results. My twins were attached at an earlier stage and over a more extensive area of the flank: they formed a common region of the midgut, which might serve as a route for germ cell migration. Thus, the converse of Volpe and Curtis' results should not be held to validate their hypothesis, without further experimental refinement.

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The objective of our study (1), as clearly stated in our introductory remarks, was to explore "the possibility that the germ cells [of frog embryos] can or do enter, or even occasionally wander, into the blood channels." We are aware of the wealth of descriptive material in the literature on anuran development that would render such an