Ultrasonic Communication in Rodents

The evidence for ultrasonic communication in rodents has so far been circumstantial[1–4]. The work described here was a pilot experiment to determine whether the ultrasonic calls emitted by baby rodents when removed from the nest do have communication value by initiating the retrieving response of the mother, as has been suggested[1,5].

Tape recordings were made of the ultrasonic calls from a 5 day old litter of *Apodemus sylvaticus* and observations were made of the responses of lactating females of this species to these "stimulus signals" alone as relayed through an ultrasonic loudspeaker placed in their cages. Other signals were also used to control for the effects of background noise and other sounds (Table 1). The loudspeaker was placed on one or other side of a "T" partition in the end of the cage away from the nest. This gave the females the choice of entering one of two compartments in response to the relayed signals. The response was scored as positive if the female first entered the compartment containing the loudspeaker, negative if she entered the other first and nil if she did not emerge from the nest within 5 min of the onset of the signal. When different signals were relayed into each compartment simultaneously, one compartment was designated positive, the other negative. The compartment into which each successive signal was relayed was decided by tossing a coin and the intensity of the signals was adjusted to a realistic level before tests began. The signals each lasted between 1 and 5 min and they were presented in varying order. The "stimulus signal" was relayed up to 18 times at any one test session. Throughout the tests, no signal was relayed until the female had been on the nest for at least 2 min and the "stimulus tape" was only presented after at least one nil response to a control stimulus.

Five adult female *Apodemus* were used on twelve different occasions. All had litters aged between 5 and 10 days. Observations were made in red light. Four of the females were given one or more retrieving tests with live young within 7 days before the acoustic tests. The females retrieved all the test pups to the nest.

Table 1. RESPONSES OF *Apodemus sylvaticus* LACTATING FEMALES TO ACOUSTIC SIGNALS

Signal: Positive	Signal: Negative	Total No. of tests (110)	No. of responses: Positive	No. of responses: Negative	No. of responses: Nil
Tape recorder motor noise		17	0	0	17
Recorded background noise	—	23	1	0	22
Artificial 45 KHz pulses	—	9	0	0	9
Stimulus tape	—	47	30	9	8
Motor noise	45 KHz pulses	3	0	0	3
Recorded background noise	45 KHz pulses	2	0	1	1
Stimulus tape	45 KHz pulses	9	8	1	0

The results are summarized in Table 1. Out of 110 presentations of different signals, only three responses to control stimuli and nine negative responses to the "stimulus tape" occurred. These together represent approximately 11 per cent of the total tests. A response to the "stimulus tape" occurred in forty-eight out of fifty-six presentations (86 per cent) and thirty-eight of these forty-eight responses (79 per cent) were positive (the "correct" choice between two chambers). Five of the nil responses to the "stimulus tape" were shown by the female that did not have a previous retrieving test. The other three nil responses came at the end of testing sessions, and habituation may be a factor here. Seven of the ten negative responses to the "stimulus tape" were given by another female during a 1·5 h testing session. Three of these were to the sixteenth, seventeenth and eighteenth (final) presentations of this signal after eleven positive responses, seven of which were in succession.

The females generally reached the loudspeaker within 5–30 s of the onset of the "stimulus signal". On several occasions the female left the nest with the young still attached to her nipples. Often she stopped outside the nest, pulled the young off and replaced them before entering a test compartment.

These results are a clear demonstration that the ultrasonic calls of *Apodemus sylvativus* babies do have communication value to the mothers of this species. The mothers are obviously responding to acoustic signals only. There are no visual, olfactory or tactile stimuli to control for. The females are not rewarded by retrieving a baby and therefore cannot learn the response. This lack of reinforcement, however, may account for the declining scores during prolonged testing sessions. The motivational effect of these calls emitted by stressed young must be very strong to induce the mothers to leave the nest, often rapidly and probably against a counter drive to stay and suckle. They are presumably of survival value by initiating the retrieving response of the mother and so restoring distressed young to the nest, their source of vital food and warmth.

This technique of scoring the responses of females to purely acoustic signals offers tremendous scope for investigating many aspects of this response. some of which are to be studied in this laboratory.

I thank Dr J. D. Pye for helpful advice and criticism and Mr S. M. Godson for maintaining the equipment. The work was carried out under a fellowship from the Royal Commission for the Exhibition of 1851 and was sponsored in part by the US Air Force Office of Scientific Research through the European Office of Aerospace Research, OAR, US Air Force, under a contract to Dr Pye.

Gillian D. Sewell

Department of Zoology,
King's College London,
Strand, London WC2R 2LS.

Received February 17; revised May 1, 1970.

[1] Noirot, E., *Ann. Soc. Roy. Belg.*, **95**, 47 (1965).
[2] Sewell, G. D., *Nature*, **215**, 512 (1967).
[3] Sewell, G. D., *Nature*, **217**, 682 (1968).
[4] Sewell, G. D., thesis, Univ. Lond. (1969).
[5] Zippelius, H. M., and Schleidt, W. M., *Naturwissenschaften*, **43**, 502 (1956).

Models for the Brain

I agree with the contention of Willshaw, Buneman and Longuet-Higgins, in their response to my communication[1], that the associative net they proposed[2] performs the specified function as well as the hologram. Two of the most striking capabilities of human memory, however, are not present in their network. The first is our ability to recognize a person we know, when he appears in our field of view, which may contain a hundred more people. The sudden flash of recognition we may feel, this absolute certainty of "this is him and it can be nobody else", is not just a subjective emotion, but is apparently evoked only by an extremely reliable and fast form of information processing in our brain. This function of recognizing is also performed by the two-dimensional hologram, as the appearance of a bright light point in the image plane of the optical arrangement, and the brightness and sharpness of the light point are a scientific measure of the degree of recognition.

The second capability is our ability, after recognizing a person, to recall quickly a considerable amount of the information we have about this person. In an optical arrangement, the recognition signal given by the two-dimensional hologram provides the instruction for generating total recall of the relevant information from a three-dimensional hologram (text and figure on page 34 of ref. 3).

As pointed out before[1], simple postulates about the properties of a three-dimensional neurone network allow it to perform these same two essential functions of human intelligence as can be done by the hologram.

It is true that the scientific efforts to explain the capabilities of human intelligence as a theory of brain action are necessarily in a beginning state. There is little doubt, however, that we have the foundation for this