UC Davis
UC Davis Previously Published Works

Title
Ultrasonic vocalisations facilitate sexual behavior of female rats

Permalink
https://escholarship.org/uc/item/1rf877x4

Authors
Hart, LA
McIntosh, TK
Barfield, RJ

Publication Date
2016-01-20

Peer reviewed
Ultrasonic vocalisations facilitate sexual behaviour of female rats

Ultrasonic vocalisations commonly occur during social interactions among rodents. During mating, adult male and female rats (Rattus norvegicus) emit brief 50–60-kHz ultrasonic calls; however, the function of these vocalisations is not known. In this study, we demonstrate that these mating calls have a precise function for communication. Specifically, 50-kHz vocalisations elicit sexual activity in female rats. Female rats exhibit a series of solicitation patterns during sexual behaviour, including orientation, darting and ear wiggling. These movements excite the male and enhance the likelihood of mating, thereby facilitating copulation.

As shown in Table 1, females exposed to both treatments with vocalisation showed significantly more darting behaviour than those in the non-vocalisation treatments (two-way analysis of variance: $P < 0.01$). Similarly, both vocalisation treatments resulted in significantly shorter latencies to darting compared with control or urine alone treatments (two-way analysis of variance: $P < 0.01$). Table 1 also demonstrates that significantly higher lordosis was frequently observed during the two treatments involving vocalisations compared with the non-vocalisation treatments (Friedman analysis of variance: $P < 0.001$).

It was generally observed that vocalisations occurred in an episodic fashion during the 10-min test period. The sexual responses of the female seemed to follow the fluctuations in vocalisation very closely. When vocalised females slowed or ceased, there was a decrease in the rate of solicitation; accordingly, when vocalisations were re-initiated, darting and lordosis were markedly increased in frequency. In some tests, males in the transmitting cage exhibited a transition from 50- to 22-kHz vocalisations. It was casually observed that at these times the females in the receiving cage immediately increased their rate of darting. A point-biserial correlation showed that there were significantly more darts in tests with (median, 78; $n = 8$) than in those without (median, 21.5; $n = 24$) 22-kHz vocalisations ($P < 0.001$).

The results of this experiment demonstrate that ultrasonic vocalisations are a sufficient cue to increase darting by a female rat in the presence of a castrated male rat. This comple-

© Macmillan Journals Ltd 1978
ments our earlier finding that vocalisations prime the female to dart when she is exposed to an intact male. It seems that whether or not a male is present, vocalisations enhance proceptivity of females.

Previously, we have found that urine of males in the presence of vocalisations synergistically primed females to dart in subsequent mating with intact males. In the present study, the presence of male urine did not augment the effect of the transmitted vocalisations in the presence of a castrated male. This may reflect either the difference in the hormonal status of the stimulus male, or alternatively, whether or not the stimuli were presented in the presence of the stimulus male.

This experiment has shown that the threshold to display lordosis is reduced by ultrasonic vocalisations. To our knowledge, this is the first report of non-somatosenory cues augmenting lordosis frequency, an indication of receptivity. Detailed studies have shown how somatosenory stimulation of the female by the male initiates lordosis. It would seem, therefore, that ultrasonic vocalisations are also significant sensory inputs which influence the initiation of lordosis.

Oestrous female hamsters exhibit lordosis in response to tape recorded vocalisations of the male. Similarly, partially deafened oestrous hamsters do not normally exhibit lordosis postures in the presence of a male with which they have no actual contact. In mice, vocalisations are correlated with the sexual readiness of the male and the presence of the odour of the female, however, a causal relationship between male vocalisations and the response of the female has not yet been demonstrated in this species. On the basis of the above results and those presented here, it would seem that ultrasonic vocalisations are significant in the integration of mating activity in rodents in general.

In the present study, a changeover in the transmitted vocalisation from 50 to 22 kHz resulted in increased female solicitation behaviour. It has previously been shown that males which shift to 22-kHz vocalisations were most active in mating tests. It has also been shown that 22-kHz vocalisations sometimes occur during the copulatory sequence, particularly as ejaculation becomes imminent. This suggests that 22-kHz vocalisations during the copulatory sequence may normally function to facilitate mating. In contrast, 22-kHz vocalisation following ejaculation are generally associated with sexual inactivity. Twenty-two-kHz vocalisations also occur in a variety of other situations including solitary caging, and in agonistic encounters. Twenty-two-kHz vocalisations in an agonistic context serve to inhibit attack, but in general the functional significance of these sounds is not known. It seems that the functions of 22-kHz vocalisations in social contexts is situation-dependent. Further study will be required to elucidate these functions.

TRACY K. MCEINTOSH
RONALD J. BARFIELD
LYNETTE A. GEFER

Department of Biology,
Livingston College,
Rutgers University,
New Brunswick, New Jersey 08904

Received 14 October; accepted 26 December 1977.

**Table 1 Preceptive behaviour of female rats in response to ultrasonic vocalisations**

<table>
<thead>
<tr>
<th>Behavioural measure</th>
<th>Control</th>
<th>Urine</th>
<th>Treatment group</th>
<th>Vocalisation</th>
<th>Urine ± vocalisation</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darter (mean ± s.e.m.)</td>
<td>14.3 ± 3.0</td>
<td>16.6 ± 4.3</td>
<td>44.4 ± 8.8</td>
<td>41.0 ± 7.2</td>
<td>0.01*</td>
<td></td>
</tr>
<tr>
<td>Lordosis (median)</td>
<td>0.5</td>
<td>0.0</td>
<td>2.5</td>
<td>1.5</td>
<td>0.001†</td>
<td></td>
</tr>
<tr>
<td>Dart latency (s) (mean ± s.e.m.)</td>
<td>105 ± 48.8</td>
<td>154 ± 56.4</td>
<td>9.3 ± 2.4</td>
<td>15.3 ± 3.6</td>
<td>0.01*</td>
<td></td>
</tr>
</tbody>
</table>

*Two-way analysis of variance.
†Friedman two-way analysis of variance.


**Ultrasound rhythm of plasma noradrenaline in rhesus monkeys**

KLEITMAN has postulated that a ‘basic rest-activity cycle’ exists which is an extension of the rhythmically recurring patterns of sleep cycles in man. Such ultradian rhythms, with a periodicity of approximately 90 min in non-human primates, have been associated with motor activity and feeding behaviour. Additionally, we have reported that plasma cortisol secretion in the rhesus monkey occurs every 90-min cycles which were synchronised for an entire group of monkeys over a 6-month period, despite individual housing conditions of the animals. Plasma noradrenaline (NA) is a reliable indicator of sympathetic nervous system activity, in part because of its short half life of less than 2 min. If Kleitman’s hypothesis is correct, one might expect to see a basic 90-min rhythm for plasma NA, even though its short half life would favour the finding of a much faster rhythm. We have found a 90-min rhythm for plasma NA in the rhesus monkey, which was temporally synchronised for the experimental group as a whole. The presence of this rhythm suggests a tonic waxing and waning of sympathetic nervous system activity compatible with Kleitman’s hypothesis.

Five adult male rhesus monkeys (Macaca mulatta) weighing 6.4–8.0 kg, were housed individually in primate restraining chairs within closed, sound-attenuating booths. Lights were turned on at 0700 and off at 1815. Behaviour was observed through a one-way mirror and feeding was carried out on a restricted 4-h schedule over 1300–1700. Water was available on an ad libitum basis. Blood was collected over a 4-h period at 15-min intervals through an intravenous or intra-arterial (monkey 3) catheter which was extended outside the booth. Blood was collected (5 ml) in heparinised glass tubes and immediately spun at 2000g at 4°C. Plasma was removed and frozen, and the red cells were resuspended in 5 ml of 9% saline and re-infused immediately following the next blood drawing. Behavioural ratings were made just before each blood sampling. The state of arousal was noted according to whether the animal was asleep, tranquil, alert or excited. Blood samples were taken at 0900–1300 in experiment 1 in all five animals and, 11–60 d after this, samples were taken at 0900–1300 in monkeys 15 and 16, and 1200–1600 in monkeys 3 and 12 in experiment 2. The latter two monkeys were fed on schedule at 1300 by opening the booth and manually placing the food within. Plasma samples