The effects of togetherness on heart rate in rats*

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Fourteen of 16 rats tested in two experiments showed higher heart rates when in the presence of another rat than when alone. The effect was as consistent, though not as strong, when rats were prevented from physical contact and interaction as when they had freedom of movement. The results provide physiological support for Zajonc's social facilitation hypothesis, but do not explain how fear-reducing effects of social contact are mediated.

When two rats are placed together in an open field, they each show considerably fewer conventional signs of fear than do individual rats tested in the same situation. Rats defecate less and are less likely to "freeze" when in the company of another rat (Latané, 1969; Latané & Glass, 1968). One explanation for these effects may be that rats serve to reduce arousal for each other. Reduced arousal, in turn, would lead to lowered emotionality.

This explanation, however, is inconsistent with some other evidence which might be taken to indicate that rats become physiologically more aroused when in the presence of others. A number of "crowding" studies reviewed by Thiessen & Rodgers (1961), for example, have found that rats develop larger adrenals when they are housed together rather than alone. Zajonc (1965) cites several other studies showing greater hormonal activity in grouped than in isolated animals and goes on to develop the hypothesis that the mere presence of others may lead to physiological arousal in animals (and men) and that this effect may help explain the results of numerous "social facilitation" studies.

Although it is not impossible that the presence of others may, at the same time, both increase arousal and reduce fear, the two effects are sufficiently incongruous, the evidence sufficiently scanty, and the issue sufficiently important to justify further research. The present study

was designed to examine the effects of togetherness on heart rate—which is both a measure of physiological arousal and a response to fear.

EXPERIMENT 1

Subjects and Apparatus

A total of 20 male Sprague-Dawley albino rats about 120 days old were used. All rats had previously served in investigations of gregariousness in the open field. Ss had been housed singly and maintained on an ad lib feeding and drinking schedule for 2 months.

The Ss were tested in a 4-ft-diam circular open field. The field was painted white with black lines and was surrounded by an 18-in. wall. It is described more fully in Latané (1969).

Measuring Heart Rate

Approximately 2 weeks before testing, 30-ga stainless steel electrodes were implanted in 10 of the rats. One electrode was placed subcutaneously above the right shoulder blade, and the other on the left side at the level of the posterior end of the rib cage. The remaining 10 rats were not operated and were used simply as partners in the "together" condition of the experiment.

Heart rate was monitored by attaching cut-down women's hair clips to the recording electrodes. These clips were soldered to thin insulated lead wires, which were braided and hung down over the center of the field so that rats had freedom of movement. The leads were, in turn, soldered to a cable which ran to the ac coupler of an Offner Type R dynograph.

Procedure

Testing was done in three consecutive 5-min periods. First, the clips were attached to the electrodes and the rat introduced to the open field for the first "alone" period of recording. After 5 min, a second rat was placed in the field as close as possible to the first rat for a 5-min period of "together" recording, during which both rats were free to run

around the open field. Finally, the second rat was again removed and a further 5-min "alone" record was obtained. For six rats, heart rate was recorded for the first 15 sec of each minute in the field. For four rats, a continuous record was obtained in order to get a larger sample of heart rate.

Results

In order to eliminate the effects of handling and the sudden introduction into the field, the first 2.5 min of data were dropped from the analysis. For the remainder of the period, heart rate was counted over 5-sec samples of the EKG record. For six of the rats, this involved selecting the most legible 5-sec portion of the 15-sec samples. For these rats, there were 8 alone and 5 together observations. For the last four rats tested, the continuous record was divided into consecutive 30-sec portions. From these, the most legible 5-sec samples, approximately equally spaced in time, were selected. Thus, for these rats, there were 15 alone observations and 10 together observations. The mean heart rates for each individual rat are shown in Table 1.

As is clear in Table 1, the presence of another rat markedly increased heart rate for 8 of the 10 rats. For 2 of the rats, there was virtually no effect. The mean heart rate in the alone condition was 436 bpm. In the together condition, it was 470 bpm, an average increase of over 34 beats ($p < .05$ by t test¹). This increase was about 8% of the alone base rate.

Discussion

The results indicate that the effect of togetherness in rats is to increase heart rate. Although the presence of another rat may directly stimulate physiological arousal, two mediating links are possible. First, heart rate may increase because rats are more afraid in the together condition than when alone. This is not very likely, since the available evidence strongly suggests that the opposite relationship holds

Table 1
Mean Heart Rate (Beats Per Minute) for
Individual Rats Alone and
Together: Experiment 1

Alone Heart Rate	Together Heart Rate	Increase in Beats/Min
463	523	60
462	494	32
462	461	-1
456	535	79
450	476	26
426	454	28
418	448	30
415	408	-7
409	470	61
402	437	35

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Table 2
Mean Heart Rate (Beats Per Minute)
for Individual Rats Alone and
Together: Experiment 2

Alone Heart Rate	Together Heart Rate	Increase in Beats/Min
342.0	345.7	3.7
340.5	348.2	7.7
331.1	337.0	5.9
323.1	325.6	2.5
314.2	316.5	2.3
284.7	293.2	8.5

(Davitz & Mason, 1955; Latané, 1969; Latané & Glass, 1968; Morrison & Hill, 1967).

A more plausible possibility is that heart rate is higher in the together condition because rats stimulate each other to move around. In order to test this possibility, it would be necessary to directly control the mobility of the Ss when alone and when together. Experiment 2 attempted just that.²

EXPERIMENT 2

Subjects and Apparatus

Six Charles River Type CD male albino rats approximately 250 days old and 304 g heavy were used in the experiment. They had been maintained in separate cages on ad lib food and water from their introduction to the colony at about 90 days of age.

A Scientific Prototype standard chamber was modified to permit the insertion of both translucent and opaque panels, dividing the chamber into halves. Each half was lit by a 7-W house lamp that remained lit throughout the session. EKG records were made with electrodes mounted on thoracic belts (Ferraro, Silver, & Snapper, 1965) amplified and recorded on a Grass Model IID EEG. Cardiac R waves were digitized separately through a Schmitt trigger circuit and counted in 10-sec bins.

Procedure

To produce stable baseline heart rates (Black, Fowler, & Kimbrell, 1964; Snapper, Ferraro, Schoenfeld, & Locke, 1965), each rat was exposed to 30 sessions of adaptation alone in the box, with the thoracic belt attached. Ten 60-min sessions were run during which the barriers were periodically raised and lowered. The rats were shaved weekly, and electrode paste was applied at the start of each session.

Testing sessions began with a 30-sec "alone" period, during which the opaque barrier was in place so that there was no visual or tactile contact between the animals. At the end of 30 sec, the opaque barrier was raised, permitting visual contact for 2 min, after which the opaque barrier was again inserted for the remaining 60 sec of the trial. The animals were then

returned to their cages, and the electrode paste washed away with alcohol to prevent irritation and caking. This procedure was run for 5 consecutive days.

Results

The extensive adaptation training and the limited movement space produced relatively stable heart rates in the rats both within and between days. Although the data are not strictly comparable, the average standard deviation in beats per minute in this experiment was only 6.6; in Experiment 1 it was 27.4.

As in Experiment 1, however, rats had a higher heart rate when they could see another rat. Table 2 presents the results. Each of the six rats showed an increase in heart rate during the period of visual contact with another rat ($p < .05$ by sign test). The mean heart rate "alone" was 322.6; during visual contact it was 327.7, an increase of 5.1 beats or 1.6% of the alone base rate.

DISCUSSION

Although both experiments are consistent in showing increases in rats' heart rates when they were put together, this effect was less dramatic in the second experiment than in the first. Compared to an increase of 8% in Experiment 1, rats in the second experiment showed a heart-rate increase of less than 2%. One reason for this difference may stem from the extensive adaptation rats received prior to Experiment 2, leading them to be, in general, relatively unresponsive. Another reason may be that Experiment 2 rats were relatively restricted in their movements and thus unable to lead each other into such gross bodily activities as chasing each other about. A third possibility is that the transparent barrier in the second experiment itself reduced the impact of the rats on each other. Latané (1969) has shown that, although rats are very much attracted to each other in the absence of a barrier, they are only slightly attracted to a caged rat.

Whatever the reason for the different magnitude of effects in Experiments 1 and 2, it is clear that these data are in accord with Zajonc's (1965) hypothesis that togetherness leads to arousal. Fourteen of the 16 rats tested showed increased heart rate when in the presence of another animal ($p < .005$ by sign test). Such data from animals are particularly interesting, since comparable findings in humans could be explained in terms of such presumably human processes as self-consciousness, stage fright, or evaluation apprehension.

For rats, togetherness seems to lead to autonomic arousal. Schachter's (1964) cognitive-physiological theory of emotion suggests that unexplained

autonomic arousal may cause an organism in effect to search for an interpretation, which, depending on cues available in the environment, may result in an appropriate emotion. One implication of this theory is that arousal, such as that produced by the presence of others, should generally "multiply" whatever emotions are appropriate to the situation. This would provide an explanation of such puzzling phenomena as panics, riots, and mass revels. By itself, it would not account for the general reduction in fear-related behaviors such as freezing and defecation often observed in rats. The presence of others, however, may not only enhance the potential for emotion, it may also affect its direction, either by distracting the animal from fear-inducing elements in the environment or by itself providing an alternative nonfear interpretation for arousal. Thus, the two effects are not necessarily incompatible.

While the present research shows that togetherness increases arousal, previous research has shown that arousal can increase togetherness. Joy & Latané (1971) found that rats injected with adrenalin were more affiliative than placebo rats, who, in turn, were more sociable than animals given chlorpromazine injections. Cappell & Latané (1969) found that caffeine led to an increase and alcohol to a decrease in affiliation as compared to placebo controls. There must, however, be a limit on at least one of these relationships—otherwise, any group of rats would inevitably turn into a great quivering huddle.

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NOTES

1. All p values are two-tailed.
2. Eliot Shimoff conducted Experiment 2 and contributed substantially to its design and analysis.