The effect of food deprivation and expectancy on heart rate

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Ss fasted for 24 hr. after being on a controlled diet. Group A expected to fast for 24 hr. and had HR measured with food cues present. Group B expected to fast for 36 hr. and were tested without food cues. At the 24 hr. mark, Group A showed significantly higher heart rate. It was concluded that significant HR arousal occurs in deprived human beings anticipating immediate satiation.

In 1959, Malmö postulated that physiological excitation could occur as a result of food and water deprivation. In support of his hypothesis, Malmö cited Belanger & Feldman (1962) where rats were serially deprived of water for up to 72 hr. A monotonic relationship between deprivation and heart rate was observed when HR measurement was taken while the animal was in the presence of the drinking apparatus. Campbell & Sheffield (1953) found that in the presence of environmental stimulation, food deprived rats were more active than satiated ones.

Asdourian & Rimbey (1965) recorded the heart rate of seven adults at deprivation levels varying between 30 and 35 hr. They found no difference between HR measured after deprivation and HR measured on control days. The first author was an S and the other six Ss were graduate students familiar with the purpose of the study, thus introducing the possibility of experimenter bias or at least uncontrolled expectancy.

The present study compared the heart rate of a group that expected to be deprived for 24 hr. and that of a group which expected to be deprived for 36 hr. In the case of the 24 hr. group, food was present at the time of recording the HR. It was predicted that the 24 hr. expectancy with food stimuli present would show higher activation than the 36 hr. expectancy in which there were no food cues present during the HR recording after 24 hr. actual deprivation.

Method

Subjects. Twenty male undergraduates, ages 18 to 22 years, served as Ss in two groups of 10 Ss matched for baseline HR.

Apparatus. Ss sat on a reclining chair, wearing earphones which carried the sound of a white noise generator at a constant intensity. Redux electrode paste was applied to the underside of the wrist and 1 in. x 2 in. spring clamp electrodes were attached. HR was recorded on a Grass Model 5C polygraph.

Ss filled out a daily mood scale which asked him to rate his feelings on a series of seven point adjective scales such as hungry-not hungry, etc. After HR had been taken the first time, each S filled out the medical inventory and was given instructions.

Design. Group A ate a controlled diet followed by a 24 hr. fasting period, and HR recording with food cues present. Group B ate a controlled diet, expected to fast for 36 hr. and had HR measured after 24 hr. with food cues absent.

Procedure. Ss came in for four recording sessions at which time HR was recorded for 14 min. The controlled diet began at noon on the day of the first recording session. Ss ate lunch, did not eat until supper when they ate two packages of Instant Breakfast (580 calories). At breakfast they ate one package of Instant Breakfast (290 calories).

On the second day, Ss returned to have HR taken. They did not eat or drink anything that day except water. After 24 hr. deprivation, all Ss returned to have HR recorded. Group A knew that they could eat the food (Hershey bars, milk, etc.) that was placed in front of them, after the recording session. Group B expected to fast for several more hours and found no food stimuli present. Ss returned on the fourth day for final HR measurement.

Results

Changes in HR. Mean HR for the two groups was evaluated using the *t* test. Only on day three—following the 24 hr. deprivation period—was there a significant difference between the two groups ($p < .025$, one-tailed). The HR for the 24 hr. deprivation expectancy group was 9.8 beats per min. faster than the HR for the 36 hr. deprivation expectancy group after an actual deprivation period of 24 hr. for both (see Table 1).

While both groups showed a mean increase in HR after 24 hr. application of the Wilcoxon Matched-Pairs Signed-Ranks test to the data showed that the 24 hr. expectancy group had a significant increase in HR of 11.6 beats per min. following deprivation ($p < .01$).

Subjective Ratings. It was found that on the hunger rating item, Group A (24 hr. expectancy), changed significantly ($p < .01$), $T = 0$ (Wilcoxon Test) toward being more hungry following deprivation. Group B showed a non-significant change following deprivation. No between-group differences were found in any comparison of mood ratings.

Table 1. The heart rate means and standard deviations for the 24 hr. and 36 hr. expectancy groups for each of the four days of testing

	Day 1		Day 2		Day 3		Day 4	
	M	SD	M	SD	M	SD	M	SD
24 hr.	72.8	10.06	67.1	6.16	78.7	8.37	71.7	4.29
36 hr.	71.3	10.60	64.1	7.22	68.9	10.53	67.5	9.15

Fig. 1. The heart rate means for the 24 hr. expectancy group and the 36 hr. expectancy group for each of the four days of testing.

Interaction. Spearman's rank correlation was computed between the hunger ratings and HR observed before and after deprivation. While the correlations were not significantly greater than zero, it is important to note that the correlation for the 24 hr. expectancy group after deprivation was .50 as opposed to -.07 for the 36 hr. expectancy group. A test of significance of the difference between these two correlations yielded a significant $D/S_{zr-zr} = 3.78$; ($p < .01$), (DuBois, 1965).

Discussion

The results confirmed the prediction that the 24 hr. expectancy-food cues present condition would produce more HR activation than a 36 hr.-food cues absent condition. Activation was measured as HR increment over the previous control reading, following the 24 hr. period of food deprivation. While both groups showed an increase in HR following deprivation, only Ss in the 24-hr. food cues present condition showed a significant increase in HR. Present studies in our laboratory indicate that the mean HR of Ss tested without food deprivation show no significant inter-day changes.

These results generally support Malmö's 1959 con-

tention that two factors are needed for activation: (1) the internal conditions produced by a state of physiological deprivation and (2) environmental stimulating conditions at the time of testing—conditions met in the present study by deprivation and the presence of food stimuli.

In this preliminary study, there was, in fact, a confounding of the S "deprivation expectancy" and "stimulus present" variables. The two conditions were chosen and designed to maximize the S's expectancy of immediate need reduction in the one condition while minimizing it in the other. If expectancy can be thought of as a unitary variable, influenced by both instructional set (the projected length of deprivation) and relevant environmental cues (food stimuli), then the present results, both cognitive and physiological, suggest that the Ss facing a longer time until need reduction (36 hr. expectancy) may attenuate their evaluation of hunger and possibly their physiological manifestations of hunger as well.

It became clear to us that the S's "plan"—to use Miller, Galanter, & Pribram's (1960) term—is an important consideration in predicting how a person will manage his physiological resources given a situation which will affect homeostatic functions.

It is tentatively concluded that HR arousal occurs in food deprived humans anticipating immediate satiation, while those who expect to continue deprivation show less HR arousal. These results are generally consistent with Malmö's activation theory.

References

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