Heart rate and deprivation in humans¹

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Abstract

The heart rates of food-deprived humans did not increase over their control rates.

Problem

Heart rate has been used as a physiological index of activation by such workers as Belanger (1959), Belanger & Feldman (1962), and Hahn et al (1964). These authors have found a positive correlation between heart rate and the number of hours that an animal has been deprived of food or water. The significance of this positive correlation derives from the possibility that increased heart rate is but one of a number of physiological processes that show sympathetic activation under stress (deprivation) conditions. The speed up of activity of various organ systems under stress should have the general advantage that it somehow increases the random activity of organisms and thereby increases the probability that an animal will come into contact with a place or a thing in the environment which will alleviate the stress. Malmo (1959) has suggested that heart rate may be sensitive to deprivation only if there are food- or water-related stimuli in the animal's environment.

This suggestion by Malmo finds partial support in the behavioral work of Campbell & Sheffield (1953). These workers found that the activity level of rats in their home cages (measured by a stablometer) varied directly with the magnitude of hours of deprivation, provided the animals received heterogeneous stimulation. When these animals were kept in a homogeneous environment (including a steady masking noise), no significant increase in activity was observed with increasing deprivation. Recently, O'Kelly et al (1965) showed an inverse relationship between level of dehydration and cardiac activity. These workers used stomach loads of H₂O and hypertonic saline to achieve hydration and dehydration.

The present study is directed toward discovering whether or not there is a relationship between food deprivation and heart rate in humans. The choice of humans as Ss was based on the assumption that their responses to hunger and to the anticipation of food would be less "primitive" than the responses of animals. Thus, the author assumed that although the Ss knew that they would go directly to one of the local restaurants after having their heart rates taken, they would react to the situation calmly in a way that hungry animals anticipating food cannot.

Method

The Ss were six adult graduate students (two females, four males) and the first author. All of the Ss were familiar with the use of the polygraph (Grass, model

7P5A), were familiar with the purpose of the study, and thus had no anxiety attending the recording procedure. All recording sessions lasted 15 min. Two Grass EEG disc electrodes were attached to the Ss. One electrode was cemented and taped to the upper forearm, and the other to the leg just lateral to the shin bone and about midway between the ankle and the knee. The Ss remained seated in an armchair throughout the recording sessions. Electrocardiograms were always taken between 12:30 p.m. and 2:30 p.m. On days when control records were taken, the Ss were instructed to eat their normal lunch 1/2 hr. before the recording session, and to sit relaxed during the 1/2-hr. wait. On the day when the records were taken under the deprivation conditions, the Ss followed the same procedure that were imposed during the control days (except that, of course, they did not eat lunch). During deprivation, the Ss were on a liquid diet that excluded liquor, soft drinks, and drinks of any kind that contained sugar or had an appreciable caloric content—records were taken with deprivation varying between 30 and 35 hr.

Control and deprivation records were taken in the following order. Three control 15-min. EKGs were taken on different days, one 15-min. deprivation record was taken, and finally three more control records were obtained. Because of varying class and research schedules, it was impossible to allow for the same number of days between recording sessions for every S. A mean of 10 days separated all recording sessions. In computing heart rates (beats/min.) for any given day, every heart beat from each of the 15-min. records was counted.

Results

The mean of the pooled scores for days 1-3 was 82.86 (control), the mean of the scores for day 4 was 80.08 (deprivation), and the mean of the pooled scores for days 5-7 was 83.51 (control). An analysis of variance for repeated measures was performed. The differences between the means was insignificant ($F = .6478$). The three means are quite similar, with the mean for the deprivation scores slightly lower than the means of the pre- and post-deprivation scores. If any trend were to be noted, it would be that heart rate tends to go down with deprivation. Five of the Ss displayed depressed heart rates when deprived, and two showed increases.

Discussion

These results argue against any notion that cardiac activation is related to deprivation in a simple way. As in the Campbell and Sheffield experiment, it appears that deprivation must act in concert with other stimuli if it is to be effective as an activating variable. The

present study shows that even anticipation of food does not result in heart rates above the normal satiated level. It does not completely rule out cardiac acceleration due to anticipation, however, since an increase in cardiac activity may have been masked by a concurrent decrease due to deprivation (cf. O'Kelly et al). It may be that such a result can be obtained only when humans are used as Ss or possibly when infra-human Ss are given special discrimination training. In a related study, Moller (1962) reports that the heart rates of rats decrease with increasing deprivation when continuous records are taken from the animals resting in their home cages (no food-related stimuli present). Both the present study and Moller's results support Malmo's hypothesis that activation will depend upon internal conditions and external cues.

Contemporary activation theory has its roots in experimental work that showed a relationship between cortical (and thus ascending reticular) activation and peripheral stimulation and cortical activation and emotional states. The theory was extended by Stellar (1954) in a paper in which he postulated increased autonomic activity resulting from internal changes accompanying deprivation. The theory was further broadened and given impetus by a paper by Hebb (1955) in which reticular activity was assumed to be sensitive to internal drive states as well as to peripheral stimulation. The results of the present experiment cast some doubt on the generality of these last two assumptions. In view of the fact that there is a dearth of studies which bring evidence to bear on the relationship between measures of activation and indices of drives that have a gradual onset (without the confounding variable of excitement), it would seem advisable to exercise some caution in specifying general classes of stimulus conditions which might be capable of

instigating activating processes.

If future studies should confirm the notion that internal drives do not automatically and invariably activate various physiological systems, then an interesting research problem will emerge. Since deprived animals, when exposed to appropriate stimulation, invariably do display activation (physiological and behavioral), significant physiological changes which covary with deprivation and are sensitive to stimulation must take place. The search for the nature of such changes would constitute an alternative or corollary to the search for mechanisms underlying an invariant relationship between drive and activation.

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Note

1. Supported in part by a grant from the National Institute of Public Health, USPHS (No. MH 06130).