Temperature Preference in Golden Hamsters

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INTRODUCTION

The ability of the golden hamster (*Mesocricetus auratus*) to hibernate at body temperatures as low as 3° - 5° C. is well known. The question as to whether there might be an attendant behavioral temperature preference as an aspect of thermoregulation in animals which had never hibernated or in those recently aroused from hibernation has remained unexplored. Behavioral thermoregulation by rats has been studied by the technique of a conditioned bar press for heat reinforcement, under conditions of cold exposure (Weiss & Laties, 1961), mild hypothermia (Panuska & Popovic, 1963, Panuska, 1965) and hypothalamic cooling (Satinoff, 1964). These studies in general indicate that rats will undertake work in the form of an artificial, but well learned, task to assist in the recovery or maintenance of normothermic body temperatures by raising ambient temperature levels. Although this is generally an extremely useful technique, the analagous approach to studying a possible preference for cooler environments would be, at the very least, cumbersome to instrument.

The questions of immediate interest in this study were: (a) if given a choice, would an animal capable of hibernating show a preference for a cooler environment rather than a warm one, and (b) would such a preference established before

hibernation remain unchanged immediately following arousal from hibernation?

In order to approach the problem of relative temperature preference it was decided that the method of "forced choice", utilizing a simple T-maze in which the goal boxes were held at divergent temperatures, would be the most direct and preferable technique readily available. This method allows for the expression of preferential choice by the Subject (S) yet equates the number of visits to, and the total time spent in, each environment.

METHOD

Subjects

Twelve golden Syrian hamsters, naive in that they had never hibernated, were Ss for the experiment. In addition, a small control group of rats was studied. All animals were 200 ± 20 days old, had been allowed food and water *ad libitum* until the beginning of the experiment and were maintained in a holding room at a temperature of 23° ± 1° C. prior to being placed in the 5° C. cold room following the pre-hibernal experiments. The temperature of the room in which the preference trials were carried out was 19° C. The experiments were preformed in the early spring of the year during March and April.

Apparatus

The main apparatus utilized in this study was a T-maze with

an initial arm 79 cm. long and a cross-bar 102 cm. in length. The two divergent arms formed by the cross-bar of the T were 46 cm. in length. The alleys were 10 X 10 cm. in cross-section and the goal boxes were 20 cm. wide, 25 cm. long, and 15 cm. high. The temperatures in the goal boxes were controlled within ± 1° C. by adjustable bimetallic-strip thermostats. The cold box, maintained at 8° C., was housed in an ordinary household refrigerator with a hole cut in the sidewall to allow the alley to intrude into the interior. The warm goal box was kept at either 19° or 24° C. Both boxes were equally illuminated at all times and contained the same quantities of both food and bedding. The temperature of the alleyways was ambient room temperature (19° C.) Entry to the goal boxes was provided by one-way swinging doors, while quillotine doors at either side of the choice point allowed the maze to be converted to two inverted "L" configurations as is dictated by the method of forced choice.

Procedure

Ss introduced individually into the T maze or, on forced trials, the inverted "L" configuration, were allowed to explore until they entered one or the other of the goal boxes. On each trial the following information was recorded: (a) latency from leaving the start box until entering the goal box, (b) which goal box was entered, and (c) whether the trial was forced or free choice. During the experiment the warm box was at the end

of the right arm. Each S received four massed trials daily (inter-trial interval, 30 sec.) The method of forced choice was employed to equalize visits to the two goal boxes. At the start of the experiment all S's were placed on a daily 22 hour food deprivation schedule with two hours of unlimited access to food immediately following each day's running. Reinforcement consisted of permitting the S to remain in the goal box for 120 seconds. Any food pellets present were removed from the rats' mouths and the hamsters' pouches as the animals were removed from the goal box. Observation indicated that very little food was consumed while the Ss were confined in the goal boxes, though no quantitative measures of food consumption were made. Hamster trials continued for 10 days or a total of 40 trials per animal.

Experimental Treatments

1.) Nine hamsters, Group I, were allowed to choose between equally illuminated environments of 8° and 24° C. In order to satisfy ourselves further that the response of the animals was due to an affirmative choice for the cooler environment we used a small additional group of hamsters (three), Group II, which were given a choice between 8° and 19° C., the temperature of the run-ways.

2.) Following the initial trials, all hamsters in Group I were placed in a cold room (5° C.) and allowed to hibernate. Although it usually takes more than two weeks for these animals to begin hibernating, this particular group began to hibernate between

one and two days (Ave. 32 hrs.) after being placed in the cold room; a most unusual occurrence. After a four-day period of hibernation the hamsters were aroused and again tested for their temperature preference. The trials were conducted in massed blocks of ten and were begun as soon as the animals were fully mobile (approximately 50 minutes after arousal was initiated by jostling the animal). Although body temperature was not monitored it was estimated from normal arousal data that the body temperature of the Ss at that time was approximately 35° C. and rapidly rising.

3.) Although the experiments of the authors cited above have established the existence of a marked preference for warmer temperatures by rats, it was felt that a small additional series of rats tested by our procedure would be important as a validation of our results. Thus, three rats, Group III, were tested under conditions identical to those used for the naive hamsters. However, once the marked preference of the rats for the 24° C. box seemed well established (after six days, or 24 trials) no further trials were scheduled.

RESULTS

1. Response Latencies (Table I)

Although the pre-hibernative hamsters of Groups I and II had never been exposed to other than ordinary room temperatures, the relative response latencies indicated the existence of a preference for cooler environments by these animals. The mean

response latencies diminished in the order, 24° > 19° > 8° C., and a 't' test comparison showed them to be significantly different from one another at the 0.01 level. Following arousal from hibernation the hamsters of Group I reversed their response pattern and displayed a strong preference for the 24° C. box. The latency to the 8° C. box was approximately twice that to the 24° C. and significantly different at the 0.01 level.

Statistical evaluation of the response latency data for the rats to 8° and 24° C. goal boxes yielded an insignificant 't'. However, the forced choice data, as explained below clearly indicates the existence of a preference for the 24° C. goal box.

2. Forced Choice Trials

The forced choice technique, used with the pre-hibernative hamsters and the rats, required that the Ss be forced a minimum of one trial per day which, in this case, amounted to one-fourth of the total trials. The maximum number of forced trials per day was 2. In the post-hibernative hamsters the minimum number of forced trials was still 1 but the maximum number was 5, since the number of trials had risen from 4 to 10. The actual overall percentage of forced trials was 31.4% for pre-hibernative hamsters and rats, and 33% for post-hibernative hamsters. Therefore, to the extent that the percentage of forced trials is an indication of relative strength of preference, the magnitude of the hamsters' preference was virtually indentical both before and after hibernation. Looking at the forced trial data another way, if no

preference existed for one or the other of the two environments, the S would have entered one goal box or the other randomly, thus approximately equalizing the visits to each goal box as it proceeded through the day's trials and the mean number of forced trials would have approached an asymptote of 1, while the mean number of forced trials to each goal box would have approached 0.5. On the other hand, if a preference existed the mean number should approach and, indeed, reach its upper limit of 2, which would be distributed as 2 for the non-preferred environment and 0 for the preferred environment. Figures 1 and 2 contain the Free and Forced Trial data respectively. As the two figures indicate, there was little or no progressive change in the preference of the hamsters for the cooler goal box.

Prior to being placed in the cold room for hibernation the hamsters were forced to the 8° box significantly fewer times than to either the 19° (Group II) or the 24° (Group I) boxes (Table II, $X^2 = 52.17$ df 1). The pattern illustrated in Figures 1 and 2 represents the responses of Groups I and II. The groups were combined in the figures because the patterns of response to 19° and 24° did not differ significantly. Although the latency of response to 19° and 24° did differ significantly, the data were not obtained from direct choices between the two environments, but from the pairing of each of them with the 8° box.

The post-hibernative data for pattern of choice does not lend itself to a frequency polygon presentation, but the mean

number of trials in the four categories again indicates the preference shifts (Figs. 1 and 2). Out of ten trials the mean number of free trials to the 24° box was 4.33. The mean number of free trials to the 8° box was 2.33. The forced trials show the preference even more clearly, with the Ss being forced to the 8° box an average of 2.67 times and to the 24° box only .67 times (X^2 = 14.5 df 1).

Although the rat latency data indicated no differential response to the two goal boxes, a strong preference for the warmer temperature on the part of this small group of animals was demonstrated by the fact that after the third day of trials they did not enter the cool box on any free choice trials. On this basis, their predilection was highly significant (X^2 = 14.5 df 1).

In review these observations have: (1) demonstrated a drive toward cooler environments by hamsters prior to hibernation, (2) shown that immediately following arousal from hibernation the pattern of temperature preference is reversed the hamsters choosing a warmer environment, and (3) confirmed by their preference pattern that rats, a non-hibernating species, will seek out a warmer environment or, conversely avoid a cooler one, though response latencies were not sensitive to this preference.

DISCUSSION

Prior to being exposed to conditions which usually result in hibernation hamsters apparently possess what amounts to an

inverted type of behavioral thermoregulation; at least when compared to rats. This is not inconsistent with the findings of Panuska and Popovic (1963) that hypothermic ground squirrels would not bar-press for heat during the spring although rats would. The pronounced partiality for a cool environment as observed in our experiments, may not be entirely unique in that a somewhat similar phenomenon occurs in nature among desert rodents which avoid high daytime temperatures by burrowing down into the relatively cool substratum (cf. Schmidt-Nielsen, 1964).

Optimal conditions for hibernation in hamsters include the provision of nesting material, enough food for the animal to set aside a store, a cold (5° - 19° C.) environment, and time - usually in the order of weeks (cf. Lyman and Chatfield, 1955). Current evidence indicates that during this period of time in the cold, and before hibernation may be achieved, a number of necessary physiological adaptations, extending to cell-tissue level, occur (cf. South & House, 1966 and Willis, 1966). Probably these adaptive processes are permissive in the sense that they make hibernation physiologically possible when other conditions are propitious. It would not seem unreasonable to hypothesize that the operational role of the "cold-seeking" behavior might be to test the environment for low temperature which when encountered may act as a stimulus for the permissive pre-hibernal adaptations. That something of this sort is operating, is supported by the rapidity with which our hamsters began to hibernate following their initial trials during which

they actually experienced low ambient temperatures for only brief periods. The 22 hour food deprivation schedule may well have been a contributing factor also. It is possible that this hypothesis is overly complex and that the observations may be explained, at least as a first order of approximation, by stating that a hibernator simply chooses an environment which will aid in body cooling once he has become physiologically prepared for hibernation.

The explanation for the warmth-oriented behavior following arousal from hibernation is somewhat simpler. Although the body temperatures of the animals were not monitored, other measurements would indicate that their body temperatures were about 25° C. under the conditions of the experiment. Thus, the hamsters, at a period when they were still rewarming and producing heat by all available routes, were subject to a drive alalagous to that of the rats in heat reinforced bar-pressing studies. How long the post-hibernative preference for warmth persists and how soon it reverts to the pre-hibernative pattern is under current investigation.

SUMMARY

The preference of pre-and post-hibernative hamsters and rats for relatively cool (8° C.) or relatively warm (19° C. or 24° C.) environmental temperatures was tested in a T-maze using the method of forced choice to equate number of visits to, and total time spent in each environment. The findings of the

experiment were: 1 rats show a strong preference for 24° as opposed to 8° C. environments, 2 pre-hibernative hamsters show a marked preference for an 8° environment to either a 19° or 24° C. environment, and 3 following arousal there occurs a shift in preference on the part of the hamsters to a 24° environment over one of 8° C. The significance of these results is discussed in terms of possible purposive thermoregulatory behaviors.

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Fig. 1

Distribution pattern of mean free trials for pre-hibernative hamsters.

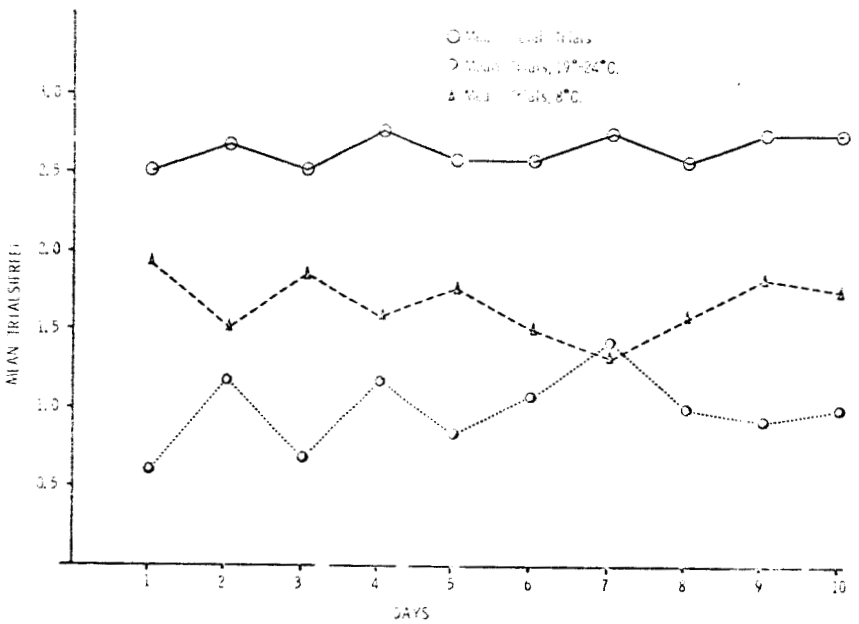
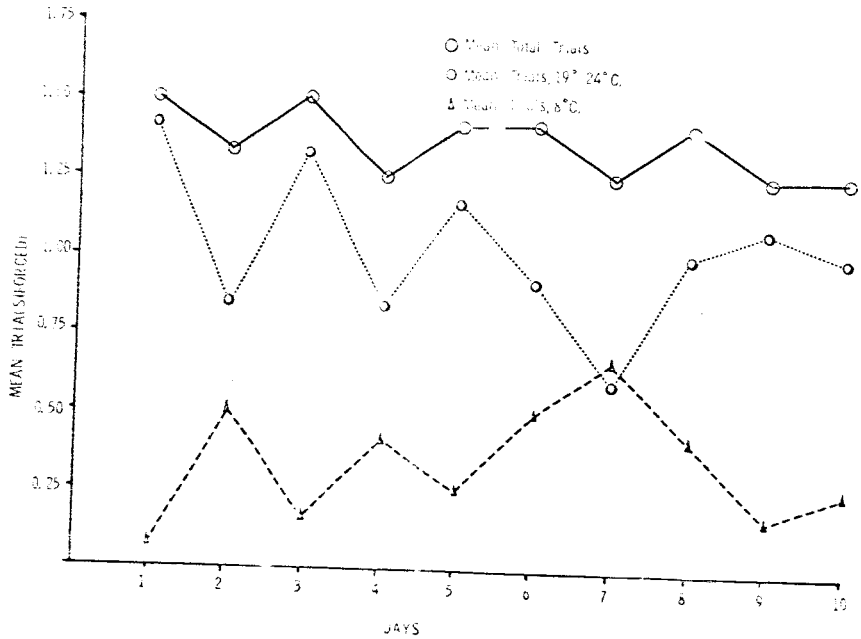

MEAN TRIALS/REF
DAYS
1
2
3
4
5
6
7
8
9
10
0.5
1.0
1.5
2.0
2.5
3.0

Fig. 2

Mean number of forced choice trials for the pre-hibernative hamsters.


1.75
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MEAN TRIALS FORCED
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DAYS

TABLE I

Mean Response Latencies (mins. ± SEM) to 8° and 19° or 24° C. goal boxes.

		Temp.	Total Trials	Mean Latency (Min.)
Pre-hibernative				
Hamsters	(combined data) (Groups I, II)	8°C.	240	1.04 ± .19
	(Group II)	19°C.	60	1.61 ± .05
	(Group I)	24°C.	180	3.29 ± .93
Post-hibernative				
Hamsters (Group I)		8°C.	45	3.77 ±1.34
		24°C.	45	1.92 ± .24
Rats (Group III)		8°C.	36	2.8 ±1.1
		24°C.	36	2.7 ± .92

TABLE II

Pattern of free and forced choices between 8° C. and 24° C. and 8° C. and 19° C. by the four experimental groups.

GROUPS

I			II			III			IV		
Pre-hibernative Hamsters, n=9			Pre-hibernative Hamsters, n=3			Rats, n=3			Post-hibernative Hamsters, n=9		
TRIALS											
Temp. (°C.)	Free	Forced	Temp. (°C.)	Free	Forced	Temp. (°C.)	Free	Forced	Temp. (°C.)	Free	Forced
8	150	30	8	48	12	8	15	21	8	21	24
24	84	96	19	32	28	24	31	5	24	39	6