Microsleep responses in the rat¹

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Abstract

Short latency sleep responses were found to occur with greater efficiency under conditions of sleep deprivation than non-sleep deprivation. Following a period of sleep deprivation the efficiency of these microsleep responses increased as a function of trials within experimental sessions and across sessions.

Problem

In two previous studies rats were maintained continuously on a slowly revolving wheel for as long as 27 days (Webb, 1962; Webb & Agnew, 1962). It seemed likely that this resistance to an exceedingly long sleep deprivation period was dependent on the acquisition of some form of sleep response. To investigate this possibility cortical electrodes were implanted on two rats and the Ss were subjected to 18-hr. sleep deprivation on a slowly revolving treadmill. Fourteen wheel stoppages lasting 300 sec. each were then administered to each rat at irregular intervals. In 50% of these stoppages an EEG pattern of sleep appeared within 20 sec. One S exhibited a sleep pattern within 2 sec. on each of 10 observations. Further observations revealed that small young animals could, by running to the front of the wheel, remain motionless while "riding" the apogee for as long as 10 to 15 sec., suggesting the possibility that the Ss were receiving short bursts of sleep (microsleep) during this period.

This report presents data on the occurrence of microsleep during systematically presented opportunities for its appearance under sleep deprivation and non-sleep deprivation conditions.

Method

The Ss were male Long-Evans rats from the University of Florida colony, with an average age of 150 days.

Experiment I. Eight Ss were used. Each S was removed from its home cage and placed on a sleep deprivation wheel for 24 hr. This wheel was 4-1/2 in diameter and 4-3/4 in wide. To minimize microsleep responses on the revolving wheel. The treadmill turned at a speed of two RPM (previous studies had used a one RPM speed). The wheel was two-thirds submerged in water. Food was available in the "deprivation wheel" but not the "test wheel." The Ss could drink from the water in which the wheels were submerged. After 24 hr. Ss were removed from this deprivation wheel two at a time and placed on a two-chambered test wheel which was constructed to permit behavioral observation of S. This "test wheel" was an exact replica of the "deprivation wheel" except for its having Plexiglas walls to permit visual observation of S. These test wheels were in a dimly lit room.

After 10-min. on the stationary drum, the drum was started and revolved continuously for 20 min. At this time the test wheels were stopped and brightly illuminated for 3 min. The latency of sleep onset and total amount of sleep during this 3 min. was recorded. These measures were based on behavioral observation. S was considered asleep whenever it was completely motionless. Previous observations had suggested a high correlation between EEG sleep and behavioral motionlessness on the treadmill. The drums were again started and run for 5, 6, 7, 8, or 9 min. followed by a 3-min. stoppage. The drums were alternately started and stopped until each of the five rotation times had occurred once. This resulted in six 3 min. recording periods. The rotation times were varied for each pair of Ss in an irregular order each day. After the sixth stoppage the wheel was started and the two Ss were then returned to their home cages. Approximately 46 hr. after the initial test session the Ss were again placed on the deprivation wheel for 24 hr. At the end of this time a second test session began. The total cycle was repeated six times. Thus, every three days, six 3-min. sleep observations were obtained under 24 hr. sleep deprivation until six sessions had occurred.

After the sixth session a three-day recovery period was allowed in the Ss home cages and then the rats were placed two at a time on the test wheels and six 3-min. trials were recorded in the manner described above. This "no deprivation" control condition was repeated on four succeeding days.

Experiment II. The above procedure was repeated for six Ss except that the first six sessions were control periods and were followed by four 24-hr. deprivation sessions.

Results

Table 1 presents the results of an analysis of variance of the sleep latency and sleep time scores per 3-min. trial. This table includes only the six deprivation days from Experiment I and the six non-deprivation days from Experiment II, which serve as a control group. The four day periods are not included in the analysis. The highly significant trials effect within days in Experiment I was the result of decreasing latencies over trials (Mean sec. = 619, 314, 221, 259, 203, & 209) and increasing amounts of sleep (Mean sec. = 435, 709, 804, 757, 848, & 865). There was a similar trend in the trials of Experiment II (latency = 711, 526, 420, 428, 582, & 397; length = 366, 433, 526, 516, 414, & 549). However, a *t* test between trials 1-3 and 4-6 for Experiment II was not significant.

TABLE I Anova of Latencies and Total Time Measures

		Exp. I		Exp. II		
		Latency	Total Time	Latency	Total Time	
	df	MS	MS	df	MS	MS
Trials	5	34,159*	33,341*	5	14,650**	5,400
Days	5	5,605	3,749	5	6,680	3,344
Subj.	7	20,476*	17,150*	5	65,683*	87,253*
T x S	35	4,477	3,712	25	4,620	3,735**
D x S	35	3,613	4,196	25	5,955**	3,228
T x D	25	3,355	3,819	25	4,790	3,618
T x D x S	175	3,470	3,217	125	3,419	2,018

* Sign. .01

** Sign. .05

Differences between deprivation and non-deprivation conditions were assessed by t tests on both the latency and total time measures. Significance beyond the .001 level was obtained between all motivational conditions (Exp. I-Dep. vs Exp. I-Non-Dep.; Exp. II-Non-Dep. vs Exp. II-Dep.; Exp. I-Dep. vs Exp. II-Non-Dep.; Exp. I-Non-Dep. vs Exp. II-Dep.).

Figure 1 presents the between days data for the two experiments. Despite the insignificant days effect

Fig. 1. Mean Total Length and Latencies of the Sleep Response Across Experimental Days.

obtained by analysis of variance, the trends of decreasing latencies and increasing sleep time seen in Fig. 1 and the ordered character of the data suggested the appropriateness of further analyses of the "learning" effect (Webb & Lemmon, 1950). Significance beyond the .001 level was obtained between the mean scores from Days 1-3 vs Days 4-6 in Experiment I on both latency and total time using a t test between related measures and 7 df.

A further comparison was made between the first four days of the Experiment I deprivation condition and the four days of deprivation in Experiment II (which followed six days of non-deprivation). There was no significant difference on the latency measure. The total sleep measures were significantly different ($t=2.82$; 12 df; $p>.02$). However this latter difference favored the Experiment I condition.

Conclusions

1. Microsleep responses have a strong "motivational" component having shorter latency and longer duration under conditions of sleep deprivation.

2. Under conditions of sleep deprivation there is a decrease in latency and increase in duration of these responses as a function of the opportunity for occurrence within an experimental session.

3. There is evidence that the efficiency (shorter latency and greater duration) of these responses transfers from session to session.

4. There was no evidence of "latent learning" from six days of non-deprivation experience prior to deprivation.

References

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Note

1. This research was supported by NIH grant MH-03881. The invaluable assistance of Robert A. Levitt is gratefully acknowledged.