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somewhat lower rate. The EEG was of high amplitude and low frequency. Spindle activity was not seen. EMG activity was sustained and more or less consistent (fig. lb). Heart rate decreased as compared with W (mean 206 beats/min). Respiration rate was lower (mean: 26 breaths/min). SWS pattern including drowsy periods comprised an average of 64.49% of the recording time.

At periodic intervals, eye blinking would stop and eyelids would close completely for a short period. This behavior typified PS periods and was accompanied by desynchronized EEG, but there were no eye movements and the EMG activity was sustained. Hippocampal 6 activity was not seen (fig. lb). Heart and respiration rates were lower compared to SWS. The mean PS percentage of total sleep time amounted to 3.34; a higher proportion occurred during dark periods. PS periods were brief (mean duration : 8.92 ± 5.52 sec).

Reference


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The Sleep-Wake Behavior of Rats

A Comparison of Cable and Telemetric Registration

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In 35 male albino rats of 400 g body weight EEG electrodes were implanted in the right fronto-occipital area of the skull and EMG electrodes in the neck musculature under nembutal anesthesia.

21 animals were prepared for cable recording (C); a steel cable spiral

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30 cm in length and 5 mm in diameter was fixed to a socket of acrylic cement (Araldit) on the head. The end of the cable had a 5-pole plug and was suspended over a pulley with counter-weight of 10-15 g.

14 animals were prepared for telemetric recording (T). Two FM transmitters operating between 100 and 108 MHz as described by Skutt et al. [6] were mounted on the head. The first transmitter recorded the EEG, the second the EMG activity. The weight of both transmitters including batteries and holder was 15 g. If no recordings were carried out transmitters were replaced by dummies. Transistor radios (Sony type 5F-94 DL) were used as receivers.

After operation the animals were placed in a phiotically and acoustically screened air-conditioned Faraday cage (20-22 °C, 55-65 % humidity) which was lighted from 06.00-18.00 h with four 25 W daylight fluorescent tubes. The rats were kept in separate transparent plastic boxes of 18 X 27 X 29 cm; they were fed and given water ad libitum.

After at least 10 days of recovery and habituation to the day-night rhythm recordings were started. Placebo substances (0.9% NaCl) were administered intraperitoneally (i.p.) 15 min before beginning the recordings. The animals were monitored by TV. Registrations were made on an 8-channel Beckman Offner at a paper speed of 1 mm/sec. Two to four animals were recorded simultaneously. We differentiated three stages of vigilance: waking (W), slow-wave sleep (SWS) and paradoxical sleep (PS). Evaluations were done by measurement of duration of each of the phases. Phases of less than 30-sec duration were added to the preceding phases. Two recording periods, 10.00-13.00 h (first period) and 13.00-16.00 h (second period) were evaluated separately.

The results are given in table I. It is evident that during the first recording period W time was longer in the C series as compared with the T series. In turn, SWS time was longer in the T series than in the C series, whereas the PS times did not differ significantly for the two recording modes. For the second recording period (13.00-16.00 h) the various phase times did not differ significantly for the two recording modes.

During the first recording period the number of W phases and the number of PS phases were not found to differ significantly for the T and C recordings; however, the number of SWS phases was significantly higher in the T records compared with the C records. In the second recording period the number of W phases and the number of SWS phases were higher in the T series than in the C series. The number of PS phases, however, was not different in the two series.

Table I
The mean duration of phases was found by calculating the quotient of the total phase time per period divided by the number of phases. During the first recording period the duration of W phases and SWS phases in the T series was significantly reduced compared with the C series. The duration of the PS phases, however, was about the same in both series. During the second recording period the situation was about the same: here, too, the W phases and SWS phases were significantly shortened in the T series as compared with the C series whereas the PS phases were similar.

The PS latencies showed a slight but not significant difference between the C and the T recordings. The duration of the first PS phase did not differ significantly in the two series.

In summary, these investigations showed that the elimination of the cable connection for electrical recordings in rats brings about an increase in total SWS time at the cost of W time. The enhancement of SWS is particularly evident in the first 3 h of recording; later on, the waking and sleeping times do not differ in the two recording situations. With telemetric recording the number of phases increases as compared with cable recordings, so does first PS latency.

Concerning our cable technique data we found the sleep-wake pattern similar to that described by other authors [4, 5, 1]. In agreement with van Twyver [7] and Webb and Friedmann [9] we could not find a sleepwaking periodicity like Weiss [10]. Often, but not consistently, we saw a short W phase at the end of PS phases [2, 5, 9, 10]. In our recordings the PS latencies were shorter than described by Khazan et al. [3], whereas the duration of the first PS phase was about the same as seen by Khazan et al. [3] and by Vanderwolf [8].

References

Van Twyver and Allison [6] investigated spontaneous sleep in the golden hamster. Using electroencephalographic techniques, they recorded 6 adult male animals over periods of 48 h. Out of the numerical data they supply from their study, a striking feature stands out, namely the exceptionally great levels of paradoxical sleep (PS), amounting to as much as 14.6% of the total recording time. However, the authors’ diagnostic criteria for sleep per se and for shifts from slow-wave sleep (SWS) to PS, and conversely, appear to be insufficiently defined; also, there is no exact information concerning the circadian sequence of waking (W), SWS and PS episodes in the paper referred to. In our opinion, accurate documentation of such circadian sequence is of fundamental importance to the comparative physiology of sleep. The aim of the present work was to extend
1 Supported by a grant of the Polish Academy of Sciences.