

SOME INDICES OF BRAIN ACTIVITY IN "RAPID"
SLEEP PRECEDED OR NOT PRECEDED
BY Δ -SLEEP

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The psychophysiological characteristics of premature (without preceding Δ -sleep) and regular periods of "rapid" sleep (RS) were investigated during a daytime attack of narcolepsy. Significant differences were found in the character of the dreams, their emotional content, and the patients' subjective assessments of the quality and duration of sleep during the attack. Functional interaction between RS and the preceding state, which in the normal sleep cycle is Δ -sleep, is deduced.

KEY WORDS: Δ -sleep; "rapid" sleep; narcolepsy; dreams; assessment of time.

The results of an analysis of functional interaction between Δ -sleep (stages III and IV of the phase of "slow" sleep - SS) and "rapid" sleep (RS) in man are described in this paper. Attacks of daytime sleep arising in patients with polysymptomatic narcolepsy were used for the analysis. Such attacks frequently begin with a period of RS actually during the waking state, or after a few minutes of SS in the form of stages I and II, and they may also incorporate a period of RS, to complete the whole sleep cycle, i.e., arising after the stages of Δ -sleep [1, 5, 8-11, 13, 15]. Since brain activity in RS is manifested by special psychophysiological phenomena and, in particular, by dreams, the functional characteristics of RS preceded or not preceded by a stage of Δ -sleep, could be compared.

EXPERIMENTAL METHOD

Altogether 92 periods of daytime sleep in 10 patients were investigated. Polygraphic recordings (EEG, EMG of the submental muscles, electrooculogram, PGR by Tarkhanov's method) were carried out twice a day: at 10-11 a.m. and 3-4 p.m. In accordance with the accepted classification [14] the stages and phases of sleep were defined and compared with the indices of psychological activity during sleep, as revealed by questioning the patients after awakening (the presence of subjective experiences, their character, estimation of the duration and depth of sleep, subjective state after sleep). The estimate of the duration of sleep was regarded as correct if the deviation from the actual duration did not exceed ± 15 min for 1 h of real time.

EXPERIMENTAL RESULTS

As Table 1 shows, "premature" RS (arising at the beginning of the attack) occurred in 74 cases (groups 1-4). On awakening immediately after premature RS (group 1) the patients, as a rule, reported having had unusual dreams during sleep, of a very vivid and emotionally charged character (confirmed in some cases by objective data, such as the appearance of spontaneous PGRs), with the incorporation of the test situation, its procedures, or the experimenter into the content of dreams (for example, "...savages with knives surrounded me and tried to pull the electrodes out of my head, but I resisted").

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TABLE 1. Characteristics of Psychological Activity during Attack of Daytime Sleep of Varied Structure (in narcolepsy)

Group of observations	Structure of period of sleep	Number of observations	Duration of attacks (min)	Duration of SS (min)	Character of reports on psychological activity experienced			Assessment of duration of period of sleep			Assessment of depth of sleep	
					unusual dreams	ordinary dreams	no dreams	over-estimate	correct	under-estimate	superficial	deep
1.	Premature RS	15	12—35	—	12**	1	2	2	5	8	14**	1
2	Premature RS + stages I and II of SS	17	36—67	16—46	9	—	8+	1	7	9	11	6
3.	Premature RS + stages I, II, III, and IV of SS	27	48—85	27—53	3++	2	22**	2	12	13	8+	19*
4.	Premature RS + stages I, II, III, and IV of SS + regular RS	15	47—105	40—78	—	13**	2	2	11*	2	3	12**
5.	Stages I, II, III, and IV of SS + regular RS (without premature RS)	4	45—67	39—55	—	3	1	—	3	1	1	3.
6.	Total number of attacks with regular RS (groups 4 and 5)	19	45—105	39—78	—	16**	3+++	2	14	3**	4	15**
	Stages of SS (without RS)	14	39—70	39—70	—	—	14**	—	1	13**	12**	2+++

Legend. 1) Significance of characteristic of group of observations for a particular feature (criterion of signs): $P \leq 0.05$ (*), $P \leq 0.01$ (**), $P \leq 0.001$ (***). 2) Significance of differences from previous group of observations (Student's criterion): $P < 0.05$ (+), $P < 0.01-0.02$ (++) , $P < 0.001$ (+++).

The addition of a phase of SS to the premature RS with awakening both from its initial stages (observations of group 2) and from stages of Δ -sleep (group 3) was manifested as a steady decrease in the frequency of reports of unusual dreams, a reduction in their emotional content, and an increase in the number of reports in which dreams were completely denied. The more the extended the phase of SS following premature RS, the more marked these changes were (for the shift for group 2 compared with group 1 $P < 0.05$, and for group 3 $P < 0.001$).

If the patients awakened from regular RS, completing the sleep cycle, and with (group 4) or without (group 5) an initial episode of premature RS, the character of the reports after awakening was considerably modified: unusual dreams were absent and in most cases the patients reported ordinary dreams (the differences from the preceding groups were highly significant, $P < 0.001$). These dreams were less emotionally charged (compared with the premature RS), they were connected in their content with past events, they often contained an element of unreality, but they never incorporated the experimental situation or the participants.

If the narcoleptic attacks consisted of stages of SS only (group 6) the patients on awakening reported absence of dreams, and this differed significantly ($P < 0.001$) for the reports after periods of sleep including an episode of RS (regular, premature, or both together), except in cases in which premature RS was accompanied by an extended phase of SS, including Δ -sleep (group 3).

Spontaneous PGRs, whether in Δ -sleep or in regular RS, were virtually never observed during the narcoleptic attack.

Subjective assessments of duration of sleep until the time of awakening were characterized by an approximately equal number of underestimates and of correct + overestimates. Inclusion of a regular RS phase in the period of sleep (groups 4 and 5) led to a sharp decrease in the number of underestimates of the duration of this period, with significant preponderance of correct estimates. After periods of sleep including only stages of SS (group 6) underestimates of their duration were predominant. The differences between groups 1-3 and groups 4-5 in their estimates of the duration of true sleep were just significant (Table 1).

After awakening from premature RS (group 1) patients as a rule stated that the sleep was unsatisfactory: they were tired after it, they felt short of sleep, and they assessed the sleep as "superficial." With an increase in the proportion of stages of SS in the periods of sleep the number of estimates of sleep as "deep" increased and if stages of Δ -sleep were included in these periods (group 3) they became predominant. After wakening from regular RS (groups 4 and 5) satisfaction with sleep and its assessment as "deep" were predominant. If, however, the narcoleptic attack consisted only of stages of SS (group 6), the sleep was assessed by the patients as "superficial."

The results indicate significant differences in the content of the psychological processes during RS, whether it was preceded or not preceded by an extended phase of SS or, in particular, stages of Δ -sleep. The unusual character of the dreams in premature RS (direct reflection of the experimental situation in their content, their vividness and high emotional charge; see also [12]) must, evidently, be associated with the onset of this RS directly from a waking state or after a short time. As a result, the psychological activity that took place before going to sleep appeared to be incorporated into the specific processes that determined the presence of sleep experiences. Passage through an extended phase of SS or, in particular, stages of Δ -sleep before regular RS probably resulted in the content of the dreams in RS being determined not so much by direct traces of events in the preceding period of wakefulness as the results of brain activity in these stages of SS, causing definite transformation of the trace processes mentioned above and the relationship of the content of the dreams to the more distant past.

Interaction between brain processes in SS and RS is also suggested by the results of analysis of the subjective assessments of the duration and quality of sleep. Only the completed character of the sleep cycle, with a regular episode of RS at its end, enabled the duration of sleep to be correctly (or over-) estimated in the overwhelming majority of cases and led the patient to define it as deep and satisfactory. Meanwhile, in sleep consisting only of stages of SS, underestimates of its duration were predominant, the patient described it (like sleep consisting of premature RS only) as superficial, and it did not give a feeling of rest. These findings are in agreement with results obtained earlier [3]. Incidentally, the present observations indicate functional interaction of SS not only with a subsequent, but also with a previous episode of RS*. If SS was preceded by a premature episode of RS, a considerable number of correct estimates of the

* Here, as everywhere previously, interaction between brain processes constituting the essence of these varieties of sleep is implied.

duration of sleep (about 50%) and of estimates of the sleep as "deep" was observed, and they could actually be predominant if the MS included stages of Δ -sleep. If, however, the period of sleep consisted of SS only, assessments of the quality of sleep were almost entirely negative and its duration was underestimated.

Everything stated above is in good agreement with data on functional interaction between SS and RS in healthy subjects in the processes of memory [4, 7] and of emotionally motivated activity [6], and also with suggested models linking the phases of sleep with various successive stages of the processing by the brain of information received while awake [2, 4].

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