SLEEP RESEARCH

VOLUME 20

EDITORS

Michael H. Chase Ralph Lydic

Carol O'Connor

Brain Information Service/Brain Research Institute
University of California
Los Angeles

1991

TABLE OF CONTENTS

Preface .... **iii**
Sleep Research—How to Use It .... **v**
CURRENT CLAIMS .... **vii**
ABSTRACTS **1**
BIBLIOGRAPHY **473**
KWIC INDEX **571**
AUTHOR INDEX **659**

SUBJECT CATEGORIES		*Meeting Abstracts*	*Sleep Bibliography*
1.	Books, Reviews, and Theoretical Discussions	3	475
2.	Neurophysiology—General	12	478
3.	Neurophysiology of the Visual System	35	483
4.	Physiology (Autonomic, Metabolic, Motor)	37	484
5a.	Biochemistry	54	492
5b.	Pharmacology	56	495
5c.	Endocrinology	94	508
6.	Ontogeny	97	511
7.	Phylogeny	110	518
8.	Behavior (Conditioning, Performance, Discrimination)	111	519
9.	Sleep Cycle in the Human Adult	133	521
10.	Dreaming (Physiology and Behavior)	140	522
11.	Special Features of Dream Recall	154	523
12.	Effects of External Stimuli	155	523
13.	Patterns of Dream Content	162	524
14.	Altered States of Consciousness and Biofeedback	167	525
15.	Personality and Psychopathology	168	525
16a.	Pathology and Disorders Associated with Sleep	196	531
16b.	Sleep in Other Medical Disorders	356	553
17.	Sleep Deprivation (Total and Selective)	403	560
18.	Electrosleep	—	563
19.	Instrumentation and Methodology	421	564
20.	Biological Rhythms and Altered Environments	443	567

PREDICTING NIGHTTIME ALERTNESS FOLLOWING PROPHYLACTIC NAPS OR, "HOW LONG SHOULD I NAP BEFORE THAT ALL-NIGHTER?"*

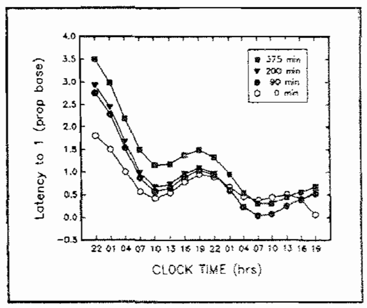
Roger R. Rosa[1] and Michael H. Bonnet[2]
[1]National Institute for Occupational Safety and Health, Cincinnati, Ohio
[2]Veterans Administration Hospital, Long Beach, California

Laboratory studies have demonstrated that napping before an extended vigil (i.e., prophylactic napping) can delay the decline in alertness during the vigil. An important practical question from this research concerns the minimum amount of sleep required to maintain a given level of alertness. Setting nap lengths at a minimum is important because biological rhythm, environmental, social, and other practical factors mitigate against sleeping during the day. Here we describe a multivariate equation for establishing the minimum nap length necessary for maintaining a desired level of alertness (as measured by the Multiple Sleep Latency Test (MSLT)) for extended operations up to 47 hours.

Complete MSLT and prophylactic nap EEG data were available from 94 of 98 normal male subjects (ages 18-28) who completed two nights of sleep deprivation in a continuous-operation study design. Eleven subjects took no nap before the vigil, 24 attempted a 2-hour nap, 23 attempted a 4-hour nap, and 36 attempted an 8-hour nap. Half of the napping subjects took triazolam to promote daytime sleep, while the other half took a placebo. A normal night of sleep, terminating at 0800 hours, and a baseline sleep latency test at 1000 hours, preceded the nap/no-nap conditions and subsequent vigil. All naps terminated at 2000 hours. MSLTs began at 2200 hours and were repeated at 3-hour intervals until 1900 hours, two days later. By the final test, nap subjects were awake for 47 hours, and no-nap subjects were awake for 59 hours. Between MSLTs, subjects were occupied with performance testing.

The multivariate prediction equation modeled alertness on the amount of prophylactic nap sleep combined with other parameters known to affect alertness, such as the number of hours awake and the circadian rhythm. Nap sleep was modeled in terms of total sleep (minutes of stages 1-4 + REM), "consolidated" sleep (minutes of stages 2-4 + REM), and the logarithm of these values. The log values modeled naps as having diminishing effectiveness as they became longer. Time awake was modeled both as a linear decreasing function, and a curvilinear, positively accelerating decreasing function. The curvilinear function modeled the decline in alertness as faster on the second night awake compared to the first night awake. Circadian rhythm was determined by the "cosinor" curve fitting method whereby a sinusoidal 24-h rhythm was calculated from a weighted combination of the sine and cosine of time. Drug condition was not entered in the model because preliminary analysis indicated minimal "hangover" effects.

The final equation was calculated via "stepwise" regression analysis whereby each parameter, and the two-way interactions among the parameters, were entered successively into the equation until the "best-fitting" subset of parameters (at $p<.05$) was obtained. Latency to stage 1 sleep was selected as the dependent variable since tendency toward drowsiness is operationally significant during an extended vigil. Subject variance was equated by expressing each subject's latencies during the vigil as proportions of their baseline (1000 hours) latency. Mean baseline latency to stage 1 was 9.4 min (SD=6.3).



The final equation, accounting for 30% of the variance, contained significant effects for log consolidated prophylactic nap sleep, hours awake (linear and curvilinear), circadian rhythm, the interaction of nap sleep (consolidated sleep, log consolidated sleep, and log total sleep) with hours awake, and the interaction of circadian rhythm with hours awake. Hours awake accounted for 18% of the total variance, while nap parameters accounted for 5%. The figure shows predicted values derived from the regression equation using the mean total sleep times for the 4 nap conditions. The powerful effect of time awake is apparent in the precipitous decline in alertness across the vigil. Nap effects were greatest during the first night and diminished through the following day and night. Since alertness following the shorter naps was above baseline until 0700 hours on the first night, these results are encouraging for most practical situations involving a 1-night vigil. Consequently, we have constructed a provisional guide to short daytime naps prior to an all-night vigil, which is based on predicted values from the regression equation. The table shows early-late morning alertness values (proportion of baseline) expected from 30-240 min naps terminating at 2000 hours. The values are based on 90% sleep efficiency with 80% consolidated sleep. It can be seen in the table, for example, that a 90-120 min nap would be required to be at 80% of baseline alertness at 0700 hours. It can also be seen that increases in alertness are linearly related to increases in nap length within the practical napping range shown in the table.

	Nap Length (min)							
Vigil Time (h)	30	60	90	120	150	180	210	240
0400	1.26	1.35	1.43	1.50	1.57	1.65	1.72	1.79
0700	0.64	0.71	0.78	0.84	0.91	0.98	1.04	1.11
1000	0.38	0.42	0.48	0.54	0.60	0.66	0.72	0.78

We designate the predicted values in the table as provisional because they are derived from stepwise regression analysis--an exploratory statistical procedure requiring validation with independent subjects. MSLT data currently being collected from other sleep-deprived subjects will be used for validation. The values are provisional also because they are based solely on young, good sleepers in a night-day, sleep-wake orientation. Extrapolation to other populations, such as shiftworkers, will require additional regression parameters to adjust for factors such as age, or degree of disruption of the sleep-wake cycle or other circadian rhythms. Nonetheless, the data demonstrate the possibility of selecting a desired level of function, at a given point in time, and calculating the additional sleep required to meet that criterion.