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DADA 17-67-C-7115-R1

A STUDY OF LONG AND SHORT SLEEPERS (U)

Final Comprehensive Report

Ernest Hartmann

George Zwilling

July 14, 1970

Supported by

U. S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Washington, D. C. 20314

Contract No. DADA 17-67-C-7115

Sleep and Dream Laboratory
Boston State Hospital

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DUPLICATE ORIGINAL

The Commonwealth of Massachusetts
Department of Mental Health

JONATHAN O. COLE, M. D.
SUPERINTENDENT

BOSTON STATE HOSPITAL
BOSTON, MASS. 02124

July 14, 1970

Commanding General
US Army Research and Development Command
ATTN: MEDDH-S1
Washington, DC 20314

RE: DADA 17-67-7115

Dear Sir:

Per your letter of April 17, 1970 we are enclosing a Final Scientific Report and Final Inventory of Government Property acquired through the above contract, which expired (after extension without funds) on February 28, 1970. Also enclosed is an inventory of equipment for contract #DADA 17-67-C-7114. This equipment was transferred in November, 1969 for further utilization under contract #DADA 17-67-C-7115.

We would like to take this opportunity to make a recommendation for the disposition of the above mentioned equipment.

Active intensive and constant use is still being made of this equipment by Dr. Ernest Hartmann, Dr. Turner McLardy, and the Boston State Hospital. Two of the seven Tufts University Basic Science Laboratories participating in a National Institute of Mental Health graduate training grant for research training in biological sciences related to mental health (Dr. Turner McLardy, Director) are Dr. Ernest Hartmann's Sleep and Dream Psychophysiological Unit at Boston State Hospital and Dr. Turner McLardy's Experimental Neurological Unit at Boston State Hospital.

Dr. Hartmann is continuing a series of human sleep studies directly related to the studies of sleep need supported under contract DADA 17-67-C-7115. The equipment is necessary in continuing Dr. Hartmann's work, now funded by the National Institute of Mental Health grant #5R01 MH-1452[illegible] involving normal human sleep and its pharmacological alteration. This NIMH grant is not able to supply money for the purchase of new EEG equipment to replace the equipment currently being used (acquired under above mentioned contract) should this equipment be reclaimed by the Army.

Dr. McLardy, in continuance of his research studies on "Unique Brain Mechanisms in the Hippocampus" (the original objective of contract #DADA 17-67-C-7114) made use of special cages and the cryostat in his "Insight Deficity After Bilateral Fornicotomy or Laterodorsalis Thalamotomy in Rats" (Brain Research, November, 1969), and is presently making use of them in his successful sulfide (rather than enzyme) blocking of the mossy fiber system of the hippocampi.

DUPLICATE ORIGINAL

Commanding General
US Army Research and Development Command
ATTN: MEDDH-S1
Washington, DC 20314

RE: DADA 17-67-C-7115

Page 2:

All the equipment provided for under the Army contracts has been and remains invaluable to Boston State Hospital. It constitutes a major factor permitting laboratory research on animals and humans to be carried out at Boston State Hospital. Due to recent cutbacks in funds from the National Institute of Mental Health, as well as the total absence of funds for equipment through the Massachusetts State Hospital system, we have essentially no way of replacing this equipment should it be reclaimed by the Army. We therefore sincerely hope that this equipment can remain at Boston State Hospital, since it is totally necessary to these active ongoin research programs.

Sincerely yours,

Jonathan O. Cole, M.D.
Superintendent
Boston State Hospital

Ernest Hartmann, M.D.
Associate Professor of Psychiatry
Tufts University School of Medicine

Director, Sleep and Dream Laboratory
Boston State Hospital

AD _____

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ABSTRACT

Adult males who always sleep less than six hours or more than nine hours per day were studied. Over 400 were screened; smaller numbers had various psychological tests and psychiatric interviews, and finally 29, free of overt medical or psychiatric pathology, were studied in the laboratory for 8 nights each of all-night polygraphic recording. Psychologically the short sleepers were efficient, hard-working, and somewhat hypomanic. The long sleepers tended to be anxious, depressed, or withdrawn. The two groups spent an almost identical amount of time -- 75 minutes -- in deep slow-wave sleep (stages 3-4), but the long sleepers had twice as much D-time (REM-time). It is suggested that there are two separate sleep requirements, a requirement for stage 3-4 sleep which is relatively constant across persons, and a requirement for D-time which is related to the personality and life-style of the individual.

FOREWORD

The investigations encompassed by this application has been approved by the committee of associates of the investigator in accordance with the Boston State Hospital's assurance of clinical research dated
and the Massachusetts Mental Health Research Corporation's assurance dated

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I. Introduction

Why the study?-- To answer the questions of what stages of sleep are variable and which stages might be dispensable. This is done by using people who are long sleepers and people who are short sleepers. Also it was done to find out what psychological characteristics distinguish the long sleepers from the short sleepers.

II. Method

A. Finding the population. Newspaper ads were used, then those who responded were screened through a series of steps. First they took the C.I.*, the Rotter Incomplete Sentences Test, answered the Sleep Questionnaire, and kept a sleep log. Then they were interviewed and took the MMPI.+ Over 400 people called and of these 260 were sent the forms. After scoring the forms 52 came for the psychiatric interview and took the MMPI. Of these 52 only 38 were accepted for the study and only 29 were actually run.

B. The laboratory nights. Each subject slept in the laboratory 8 nights. The first 2, which were considered adaptation nights, were separated by about one week, the third through sixth were consecutive nights while the seventh came a week after the sixth and the eighth one week later. On nights 3 - 5 the subjects slept the mean number of hours that they were used to according to their sleep logs. The sixth night they were allowed to sleep as long as they could. On nights 7 and 8 each subject was awakened from each D-period -- 5 minutes after the onset of the first D-period and 10 minutes after each D-period after that -- in order to elicit D-recalls and responses to a Mood Adjective Checklist. Twenty minutes after getting up in the morning on nights 1 - 6 each subject took a 30 minute version of the Wilkinson Vigilance Task. After the 8 nights were over the subjects were interviewed again and were given the C.P.I.**

The subjects were divided into groups according to sleep times and age. We had originally hoped for 4 groups, this would have given us 10 long-young sleepers, 10 short-young sleepers, 10 long-old sleepers, and 10 short-old sleepers. It seemed impossible to find qualified, long-old sleepers, so this group was eliminated, and we ended up with only 8 short-old sleepers.

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* C.I.: Cornell Index

\+ MMPI: Minnesota Multiphasic Personality Inventory

**C.P.I.: California Personality Inventory

III. Results

A. Psychological Results.

Data was available on a large number of subjects -- those who completed the study, as well as those who were eliminated at the various screening stages. The data on the C.I. and the Sleep Questionnaire were compared, at first, for all of those who returned the forms, both the accepted and the rejected ones. Then comparisons were made between the groups of accepted subjects. This was done again at the various stages of the screening process. The data from the Wilkinson Vigilance Tasks, the Mood Adjective Checklist, and the C.P.I. were obtained only from those who completed the study. The data from these sources were compared for group differences.

B. Physiological Results.

The data was collected on 29 subjects: 10 long-young, 10 short-young, 8 short-old, and 1 long-old. The subjects were compared on the basis of total sleep time, total waking time, total D-state, total stage 2, and total stages 3 and 4 for nights 3 - 5. Night 6 was compared to the previous 3 nights for indications of sleep deprivation. For all subjects, on nights 3 - 5. The number of REMS per unit time (REM density) were ascertained as an indication of the intensity of each D-period.

IV. Discussion

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A Study of Long and Short Sleepers

Introduction

What are the functions of sleep? The most common approach to answering this question has been sleep deprivation, but this has failed to provide clear answers about the basic function. In the present study we hoped to find some of the answers by taking advantage of an experiment in nature, by studying persons who require either abnormally large or abnormally small amounts of sleep. These subjects were studied physiologically and psychologically in order to answer two sets of questions. First, since we can now classify mammalian sleep into the two major qualitatively different states of S (non-REM or synchronized sleep) and D (dreaming, desynchronized or REM sleep) and, in man, S can be further divided into stages of 1 through 4, it is of interest to know what kinds of sleep the long and the short sleepers obtain and in what proportions. This would indicate whether man's requirements for each stage is variable and therefore, whether one or another stage would be relatively dispensable. Secondly, there is the question of what personalities, life styles, psychodynamics, etc., characterize our two groups of subjects with apparently very different needs for sleep.

The psychological data can help us understand the kinds of people or the life styles or activities which are associated with differing sleep needs. The physiological data may indicate which portions of sleep are needed equally by everyone and which portions are needed in differing amounts or are possibly dispensable.

Methods

Keeping these goals in mind, we attempted to find populations of people who had different sleep needs. A distinction must be made between those who obtain different amounts of sleep and those who actually need different amounts. For instance, it is quite easy to find people who obtain low amounts of sleep but they either "catch up" after a time or they complain about the lack of sleep. We did not wish to study either of these groups, but rather persons who function well while always obtaining less that 6 hours of sleep per 24 hours.

Advertisements for subjects were placed in major newspapers in New York and Boston. The notices asked for males over 20 who always slept less than 6 hours or always slept more than 9 hours per 24 hours. They also mentioned that accepted subjects would be paid for participating.

Over 400 persons responded to the advertisements and most were eliminated through a series of steps which provided some data on everyone who called. During the initial telephone conversation about one-third of all those who responded were eliminated, the remaining 260 were sent a set of forms. These forms were (1) the Cornell Index, a form consisting of 101 simple, true-and-false questions about medical and psychosomatic conditions; (2) a Sleep Questionnaire, a form asking various questions about usual length of sleep, the hours usually slept, whether the subject ever had to catch up on sleep, how long it usually took to fall asleep, and whether there were times when he deviated from his norm, also questions concerning health, medication, alcohol, drugs and smoking were included; (3) a Sleep Log to be filled out each morning for two weeks, indicating time to bed, time awake, estimated amount of sleep, whether there were any dreams and if any naps were taken; and (4) the Rotter Incomplete Sentences Test -- a fairly easily scored and relatively quantitative psychological test. (A copy of each is appended)

227 persons returned these forms, and of these 52 were both accepted and appeared for further study. The eliminations were on the basis of one or more of the following: if their home sleep logs showed a mean sleep time of more than 6 hours or less than 9 hours per 24 hours; or if there were two or more nights in the 2 week period that fall outside the appropriate range; if they scored 130 or more on the Rotter Incomplete Sentences Test; if sleep questionnaires indicated a marked variation in sleep time, if it showed that the patterns of sleep had not persisted for at least 6 months, if abnormal amounts of drugs or alcohol were used; or if serious psychiatric or medical problems were present; and if they scored 8 or more on the Cornell Index.

The 52 remaining subjects came to the laboratories for psychiatric interviews and to take the MMPI. The interviews further clarified the sleep patterns, medical histories, family sleep histories, drug histories; explored personality characteristics; and investigated any areas that had appeared problematic on the various tests. Subjects were eliminated if they were taking drugs, were judged to be psychotic or grossly unreliable, or if they were judged to be suffering from a current acute neurosis. Further, subjects were eliminated on the basis of the MMPI if they scored 2 standard deviations from the norm on any of the scales other than MF.

Of these 52 subjects 38 were found acceptable to continue, and, of these

38, 29 were actually run in the laboratories. After sleeping in the laboratory for 8 nights each, these subjects had a second, longer, interview and each took the California Personality Inventory (C.P.I.).

The laboratory sleep nights were separated so that the first two nights, spaced a week apart, were considered adaptation nights. Nights 3 - 6 were consecutive and were obtained starting one week after night 2. On nights 3 - 5 each subject was allowed to sleep the mean number of hours that he was used to getting, as indicated on the sleep logs. On night 6 they were allowed to sleep as long as they wished. This allowed us to pick up any indication of sleep deprivation as well as allowing us to study the changing patterns of sleep over the 4 nights. On night 7, about one week after night 6, and on night 8, a week later, all D-periods were interrupted -- 5 minutes after the onset of the first D-period and 10 minutes after onset of subsequent D-periods; dream reports and responses to a mood adjective checklist (copy appended) were elicited.

Within 20 minutes of awakening on nights 1 - 6 subjects took a 30 minute version of the Wilkinson Vigilance Task. This is a test designed to be sensitive to sleep loss, and was used to detect any possible sleep deprivation.

Originally we had hoped to have forty subjects, four groups of 10 subjects each, sleep in the laboratory: young (20-34 years old) long (over 9 hours of sleep per 24 hours); young short (less than 6 hours of sleep per 24 hours); old (35-49 years old) long; and old short. It proved, however, almost impossible to obtain subjects in the old long-sleeper group. There were 24 original responses in this group but all except one were eliminated. Thus at least some psychological data was obtained on subjects in each of the four groups but those who slept in the laboratory were grouped as follows: 10 young short sleepers, 8 old short sleepers, 10 young long sleepers and 1 old long sleeper; for statistical purposes only the three first groups are included.

Results

Psychological Results: Because we collected psychological data on a large number of subjects, long and short sleepers could be compared at the various stages in our screening procedure (Table 1). On the initial data received (the C.I., and the Sleep Questionnaire) we first compared all subjects, separating them according to their own assessment of their sleep time. Because

of the great variability in both groups, long as well as short, a significant difference was obtained in only one category of the Sleep Questionnaire -- that is -- long sleepers felt they could sleep, if allowed to, longer than short sleepers (we called this category Sunday Sleep).

Separating those subjects who were rejected on the basis of the forms from those who were accepted revealed other differences. The rejected older subjects, in both the long and the short groups, woke up during the night more frequently than the young subjects; the rejected long sleepers reported sleeping "more deeply" than the rejected short subjects; the rejected long sleepers reported recalling more dreams than the rejected short sleepers; the rejected old sleepers took sleeping pills more frequently than the young subjects; and the rejected young sleepers took more "wake pills" than the older sleepers.*

Of the 227 subjects from whom we received the first set of forms 52 were interviewed and took the MMPI. When we combined all of those who took the MMPI, both accepted and rejected for the full laboratory study, we found a significant difference on two of the scales. On the L scale short sleepers had a higher score than the long, and on the Si scale the long sleepers had higher scores than the shorts** When the accepted group was separated from the rejected some more differences appeared. The accepted (laboratory) short sleepers scored higher on the L scale, while the rejected older subjects had higher scores than the rejected young; on the Hy scale the rejected young sleepers scored higher than the older ones; the rejected long sleepers scored higher on the Sc scale while the rejected older sleepers scored higher on the same scale, and on the Si scale the accepted long sleepers scored higher.

(See Tables 2 and 3)

Our summaries of the interviews showed the following: the short sleepers were all either employed full-time, often more than full-time, or were in school full-time or, often, both. Several of them reported working 70-80 hours per week. They, the short sleepers, usually started sleeping their short hours around the age of 16-18, relating to increasing pressures from school and work, and, unlike most people, they had found that they could do it and even enjoy getting shorter amounts of sleep than previously. The vocations of this group included engineering, business, carpentry, and contracting, the ones still in school were often studying engineering, business or economics. The short sleepers felt quite confident about their job or school choice with relatively

* (All $p < .05$)

** ($p < .01$)

little hesitation or vacillation. Generally, they tended to be conformists and establishment-oriented in their job choices and their opinions. Psychologically, they appeared generally to be a healthy and successful group with little overt psychopathology although some had mild compulsive traits. Their entire life styles involved keeping busy and avoiding psychological problems rather than facing them. Insofar as there was pathology in this group it was in the direction of hypomania and reliance on the mechanisms of denial, avoidance, and keeping busy.

The variety of professions and interests was greater for the long sleepers than for the short sleepers. Some were unemployed, but several held responsible positions in a number of areas, some were sculptors or part-time students, while a few could be described as "hippies". Their histories indicated, again, that their sleep patterns originated during late childhood or adolescence, often just after completing high school, and always before the start of their current work patterns or life styles. Usually there was at least one other family member who had a similar sleep pattern. The views of the long sleepers were less conformist in nature than the short sleepers and some of them were quite creative in their work. Even though subjects with severe psychiatric pathology were screened out, the remaining group of long sleepers showed a great variety of psychological and social problems. They tended to be shy, some were mildly depressed, and some exhibited considerable anxiety during the interview. Almost all showed some inhibitions in the areas of sexual and aggressive functioning. They also, tended to have a number of medical and psychosomatic problems, and they frequently complained about the experiment, i.e., occasional noises in the sleep room, drafts, the removal of electrodes, etc. Because of the variation it is hard to characterize the long sleepers as a group, but they certainly included cases of depressive reactions, mild anxiety neuroses, and neuroathenia. Several, but not all, of them placed great value on sleep, or even saw it as an escape mechanism from a somewhat painful waking life. One said "I value the isolation of sleep." Another said "I sleep a lot to get away from things."

The results of the Wilkinson Vigilance Test are as follows: comparing the 20-34 year age group there was no difference between the long and the short sleeper groups on nights 3-5, the older short sleepers had a higher proportion

of false reports, perhaps suggesting both a higher motivation and a better detection capacity. The older short subjects improved on the vigilance test after night 6, when they were allowed to sleep longer than their average, while younger short sleepers showed no difference (see Table 4 Vigilance Test results).

The Mood Adjective Check List consists of eight categories of moods and and all comparisons were done for each of these categories. A significant difference was found, only when the responses were compared for trends in mood changes throughout the night. The responses indicate that the long sleepers tend to feel less "quiet" as the night progresses than the short sleepers. The responses to the other categories exhibit no significant differences. (See Table 5)

On the California Personality Inventory the short sleepers scored higher ($p<.01$) on the scales indicating social pressure, sociability, and flexibility. This and the overall C.P.I. profile showed the short sleepers to be more socially adept and more dominant in their relationships with others.

Dream-reports: Results are still being analyzed on a number of scales. This was not a major concern of the study.

Physiological Results: The physiological data was collected on a total of 29 subjects, but only 28, 10 short young, 8 short old, and 10 long young, were analyzed. During the all-night recordings the following measures were used to determine the sleep stages, scored according to the Kleitman-Dement Method. EEG -- two channels of recording -- one from occipital region and one from parietal region, eye movement (EOG) -- one tracing from each eye, and muscle potential -- one channel taken from 2 electrodes placed on the muscles under the chin. All electrodes were Grass Cup Electrodes, either silver or gold plated, placed on the surface of the skin and held in place with either Johnson & Johnson clear adhesive tape or with colloidiun (used on the scalp leads).

The data from the uninterrupted nights 3, 4, and 5 for all subjects in the three groups showed the following (Table 6): the short sleepers averaged 5.5 hours of sleep per 24 hours, the long sleepers averaged just over 9.5 hours of EEG sleep per 24 hours, although they all spent at least 9 hours in bed. The most striking result in the entire study is that despite the

great differences in total sleep time between the 2 groups, both the long and the short sleepers had almost identical amounts of slow-wave sleep, stages 3 and 4. This amount, about 75 minutes, is about average for normal subjects in our laboratories. This result is even more striking if the younger subjects, alone, are compared -- the short sleepers actually had slightly more slow-wave sleep than the long sleepers. The great differences in total sleep is made up during the other portions of sleep. The difference is quite marked in the time spent in the D-state, 121 minutes in the long sleepers while the short sleepers spent only 65 minutes in the D-state. These times fall almost equidistant on either side of our mean normal time of 95-100 minutes. The long sleepers spent about 261 minutes in stage 2 and about 44 minutes awake while the short sleepers spent only 167 minutes in stage 2 and only 11 minutes awake. (See Table 6)

Expressing these values as percentages of total time in bed, the short sleepers spent a significantly higher percentage of their total time in delta sleep than did the long sleepers, while the percentage of D-state sleep did not vary greatly. (See Table 7)

The long sleepers had more and longer D-periods. Even though their S-D cycles were longer the extra sleep obtained by the long sleepers gave them significantly more D-periods. The increased number of D-periods could be a function of the phenomenon that the majority of the D-periods come late in the night's sleep. (See Table 8)

As indicated above, the long sleepers spent more time awake. This time comes from having longer sleep latencies and more frequent and longer awakenings during the night. There was little difference in D-latency between the long young and the short young sleepers, but the older short sleepers had considerably shorter D-latencies than the other two groups. This may be related to their getting less slow-wave sleep than the younger short sleepers. The decrease in slow-wave sleep in the older group is not unexpected since age is known to affect slow-wave sleep. The older short sleepers spent more time awake than the younger ones. The short sleepers show a decline in the amount of awakenings during the night from night 1 through night 5. The lengths of time between the onset of one D-period and the onset of the next (inter-D-interval) were calculated. The long young sleepers had a significantly longer inter-D-interval than the short sleepers. However, there was no difference

when the younger and the older short sleepers were compared.

At this time the only measures of the "intensity" of the D-periods is the number of REM's per unit time (REM-density). Recovery from D-deprivation is characterized by high REM-densities and reports of active, vivid dreams come from D-periods that have high REM-densities. The long sleepers consistently had higher REM-densities than the short sleepers. This, coupled with longer D-periods, would indicate that the long sleepers had longer, more intense D-periods than the short sleepers. (See Table 9)

The sixth laboratory night was compared with nights 3 through 5 for any indication of sleep deprivation in the short sleepers. (See Table 10) Even though young short sleepers did tend to sleep slightly longer on night 6, their sleep pattern and their performance on the vigilance test did not indicate any sleep deprivation. The older short sleepers did better on the vigilance test and they had slightly longer D-latencies, but there was no other indication of deprivation.

Discussion

First of all there is the question of whether we have truly studied groups of subjects with differences in sleep need. We believe we have done everything possible -- obtaining careful sleep histories, medical histories, current sleep logs, etc., and obtaining multiple consecutive laboratory sleep studies with an opportunity to look into possible sleep deprivation effects -- so that we can most probably rule out the possibility that the short sleepers really needed more sleep but were chronically sleep deprived. In fact, unless the short sleepers were consistently lying to us, and perhaps taking daily home naps while on the sleep study, we do not see any reasonable alternative to postulating a reduced sleep need. For the long sleepers, it is more difficult to ascertain absolutely that they needed their 9 hours of sleep and could not have gotten along on less. Here we relied on the interviews, and reports on the various questionnaires and history forms. Each long sleeper stated that on various occasions he had tried sleeping less found it uncomfortable, and felt that it interferred with his functioning. Therefore, though we consider it unlikely, it still remains a slight possibility for the long sleepers, and a very remote possibility for the short sleepers, that they actually had average sleep needs and were merely obtaining unusual amounts of sleep.

Our most basic finding -- the identical and normal amount of time spent in slow-wave sleep in the two groups, and the very different amounts of D-time -- are consistent with a report on two short sleepers by Jones and Oswald (1) and with a study by Webb and Agnew on college students who reported less extreme long or short sleep (2). But what does this mean, in terms of sleep need, and factors which might affect it?

One way to characterize the groups overall might be to say that the long sleepers are poorer sleepers than the short sleepers; they clearly spend more time awake during the night, have more awakenings, and on interview generally report that their sleep is not quite so deep or satisfactory, and that they do not feel as refreshed in the morning as the short sleepers. Qualitative aspects of the EEG records also appear to support these differences: The short sleepers provide "easy to score" records: the S and D periods are well demarcated, there is very little ambiguous, hard-to-score time and there are not a great many shifts back and forth between stages of sleep. The long sleepers show not only more awakenings but more stage shifts, and often more ambiguous stretches of record as well. The long sleepers resemble various groups of mildly anxious or depressed subjects studied in our laboratory and others (3), while the short sleepers fall at the opposite extreme.

Comparing our groups with two groups studied by Monroe whom he categorized as "good sleepers" and "poor sleepers" (4), it appears that his "poor sleepers" resemble our long sleepers psychologically rather than our short sleepers, even though his "poor sleepers" were insomniac and obtained less than average sleep times.

Are the long sleepers, then, merely "well-compensated insomniacs" -- people who resemble insomniacs psychologically and who physiologically tend to sleep poorly in some senses (many awakenings, many stage shifts, long sleep latency) but who are able to compensate for this inefficient sleep by remaining asleep for a very long time?

In our view this is a partial but insufficient explanation of our data. If our EEG tracings can give us any indication as to what may be important parts of sleep, we might look first at the deep, slow waves of stages 3 and 4 normally occurring within the first hours of sleep. We have noted that the long sleepers obtain normal amounts of stages 3 and 4. If they are "compensated insomniacs" unable to obtain these slow waves efficiently we might expect

the slow-wave sleep to occur later, or spread out over the entire night. However, this is not the case; the long sleepers concentrate their slow-wave sleep early in the night as to normal and short sleepers. Then we might examine the D-periods. A night of sleep is so arranged that the additional later hours of sleep provide a great deal of D-time, but the long sleeper does not stop when he has accumulated a normal quota of D-time or of phasic events; his night contains roughly twice as much D-time and three times as many rapid eye movements within D-periods as the night of the short sleeper. The possibility must be considered that the long sleeper is not trying inefficiently to get the usual sleep, but actually requires more of a certain kind of sleep, namely D-time.

Our view, derived from this study and other related sleep investigations, is that there are two separate functions fulfilled by sleep, and accordingly two separate sleep needs. First, a need for slow-wave sleep, which appears to be relatively constant across all subjects; our guess is that this need has something to do with physical restoration. One of the independent variables found to alter the amount of slow-wave sleep is exercise; increased exercise levels are followed by increased slow-wave sleep in man (5) and in the cat (6). Human growth hormone (HGH) secretion normally shows one or two peaks early in the night corresponding to the times when most stage 3, 4 sleep occurs (7,8). When subjects switch to daytime sleep, the peak switches as well, indicating that HGH is probably secreted specifically during slow-wave sleep (7). This again suggests an anabolic or physically restorative function for slow-wave sleep.

Secondly we believe there is a need for D-time. (We base this partly on numerous human and animal studies of D-deprivation; on the basis of the present study alone, an alternative hypothesis would be that only SWS is needed.) The need for D shows considerable variation from individual to individual, and may be related to personality and psychological state. From the present correlative study we cannot firmly derive any causative explanations, but a plausible hypothesis is that the life style or personality of the long sleeper is associated with a greater requirement for D-time. We have suggested previously, on the basis of long-term sleep studies in hospitalized patients, that higher D-times were found at times of psychic pain or psychic disequilibrium with changing defense patterns (3, 9). Like-

wise we have found that women, and especially women with premenstrual tension, have higher D-times during the premenstrual phase of their cycle, a time characterized by irritability, depression and anxiety, and unstable defense patterns (10). Certainly the long sleeper is relatively anxious and depressed, and his life style involves change and worry.

On the other hand we have found that a group of patients who consistently function on little sleep and very low D-times are manic patients (11). The manic phase of illness is of course characterized by extreme avoidance of psychic pain and distress. The short sleepers show a milder form of the physiological sleep pattern we have found in mania, and in fact, as mentioned, the short sleepers are a bit hypomanic: although they are efficient and accomplish a great deal they tend to deal with problems by keeping busy, and by denial. Thus both between subjects and within subjects a pattern of pain, anxiety, or shifting defensive patterns may require more D-time at night.

In summary, then, we are suggesting two separate sleep needs, and two separate sleep functions to fulfill these needs -- a predominantly anabolic and physically restorative function fulfilled by SWS, and another perhaps more psychological restorative function fulfilled by the D-state.

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APPENDIX

Advertisement

SLEEP - Wanted Men 20-65 years old as paid volunteers for sleep studies. We are looking for subjects who normally sleep only 4 to 6 hours per day and subjects who normally sleep 9 to 12 hours per day. Sleep without interruption in an air-conditioned room and get paid for it. Call Boston State Research Center 436-1310.

Profile and Case Summary

The Minnesota Multiphasic Personality Inventory

Starke R. Hathaway and J. Charnley McKinley

Scorer's Initials _____

Name Samples of Long & Short Sleeper AS Male

Address _____

Occupation _____ Date Tested _____

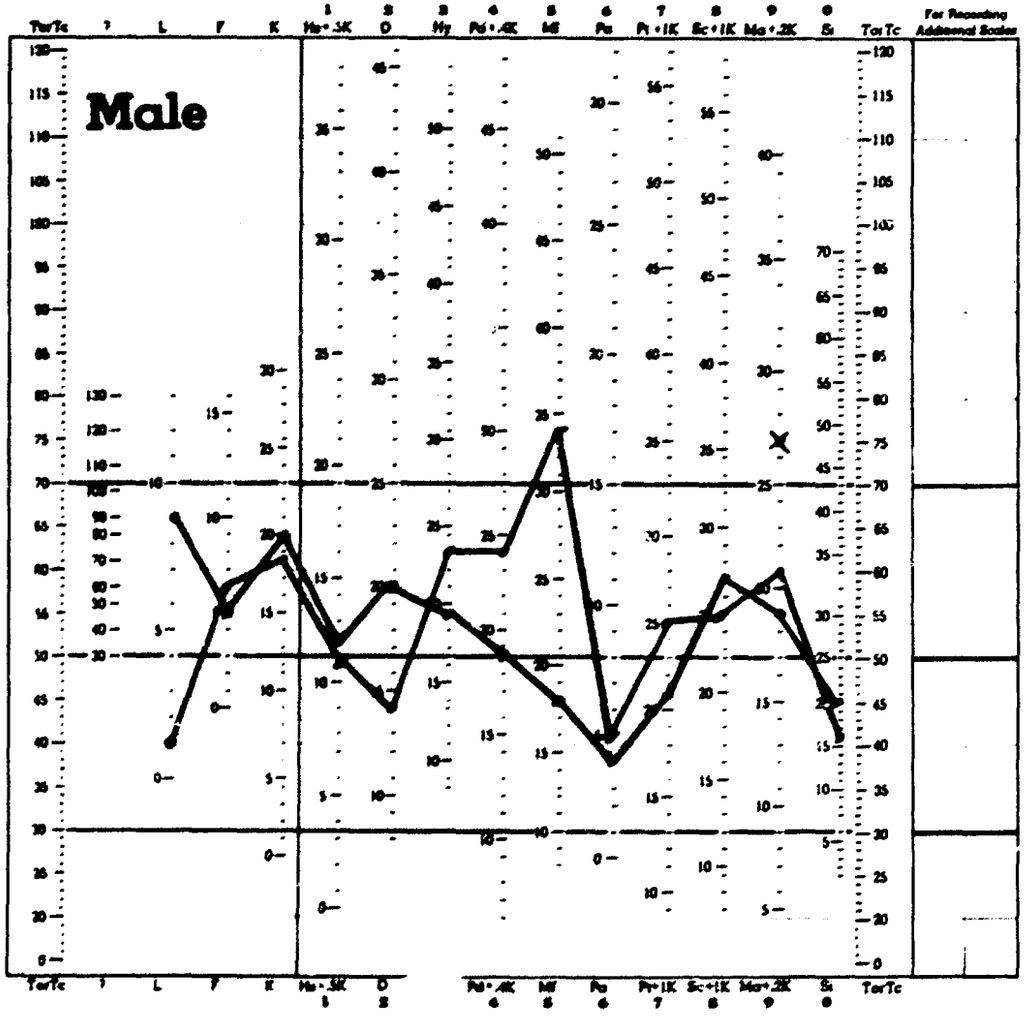
Education _____ Age _____

Marital Status _____ Referred by _____

NOTES

RED = Long Sleeper

BLUE = Short Sleeper



Raw Score																
K to be added																
Raw Score with K																

Percentage of K			
K	.5	.4	.3
30	15	12	9
29	15	12	9
28	14	11	8
27	14	11	8
26	13	10	8
25	13	10	8
24	12	10	7
23	12	9	7
22	11	9	7
21	11	8	6
20	10	8	6
19	10	8	6
18	9	7	5
17	9	7	5
16	8	6	5
15	8	6	4
14	7	6	4
13	7	5	4
12	6	5	4
11	6	4	3
10	5	4	3
9	5	4	3
8	4	3	2
7	4	3	2
6	3	2	2
5	3	2	2
4	2	2	1
3	2	2	1
2	1	1	1
1	1	1	1
0	0	0	0

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The Psychological Corporation, 304 East 45th Street, New York, N. Y. 10017

Printed in U.S.A.

65-3135

Signature _____ Date _____

PROFILE SHEET FOR THE *California Psychological Inventory*: MALE

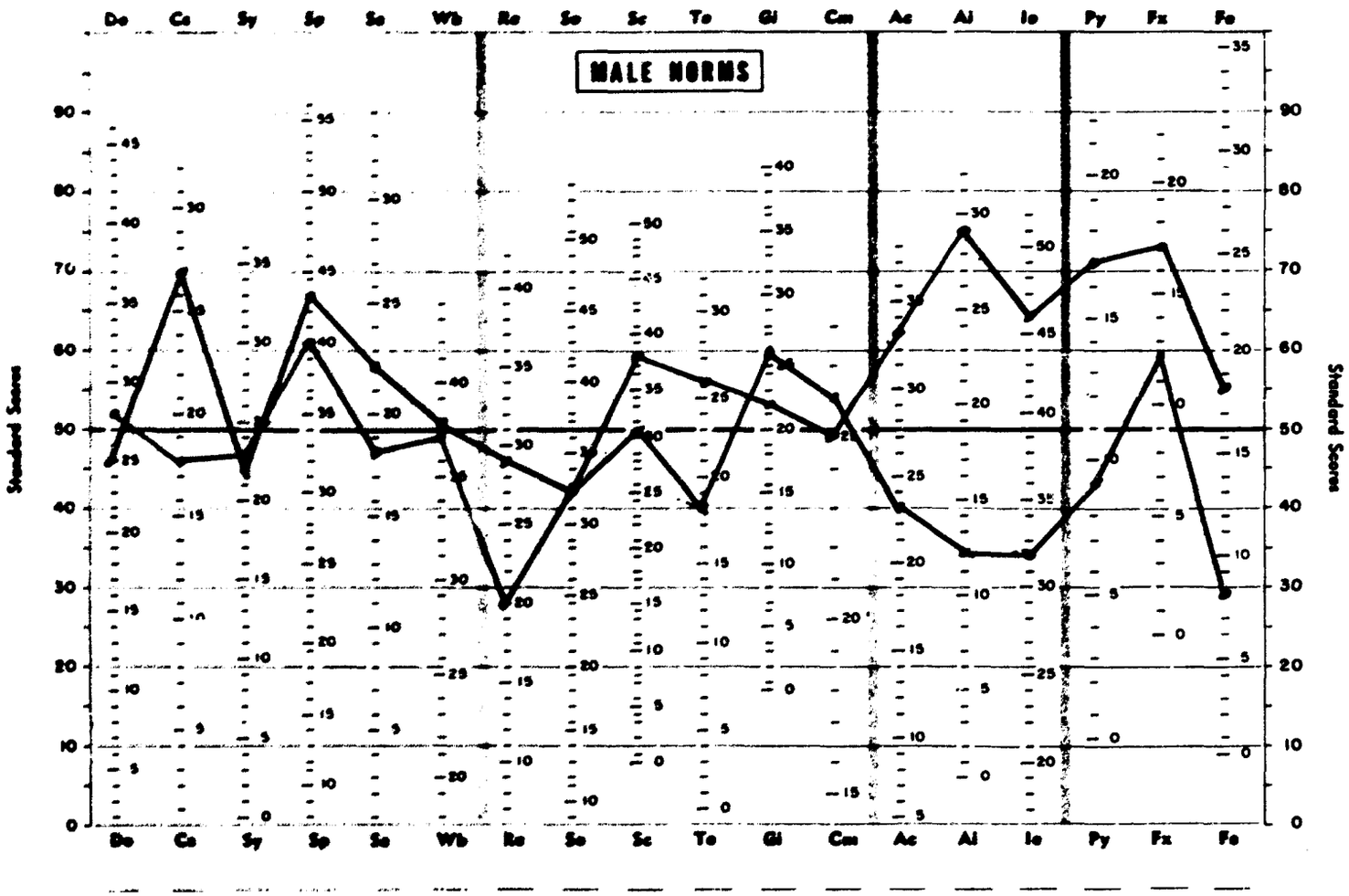
Name Samples of Long and Short Sleepers Age _____ Date Tested _____

Other Information _____

Notes:

RED = Long Sleeper

BLUE = Short Sleeper



Male Norms

Reproduced from Manual for The California Psychological Inventory, by Harrison G. Gough, Ph.D. Copyright by Consulting Psychologists Press, Inc., Palo Alto, California. All rights reserved.

SLEEP LOG

NAME:

Day of the Week: DATE	Time to bed	Time of awakening	Estimated amount of sleep	Any dreams? (yes or no)	Any naps? How long? Unusual circumstances?

INCOMPLETE SENTENCES BLANK--ADULT FORM

Name_____ Sex____ Age___ Marital Status____

Place_____ Date_____

Complete these sentences to express your real feelings.
Try to do every one. Be sure to make a complete sentence.

1. I like_____
2. The happiest time_____
3. I want to know_____
4. Back home_____
5. I regret_____
6. At bedtime_____
7. Men_____
8. The best_____
9. What annoys me_____
10. People_____
11. A mother_____
12. I feel_____
13. My greatest fear_____
14. In school_____
15. I can't_____
16. Sports_____
17. When I was a child_____
18. My nerves_____
19. Other people_____
20. I suffer_____

(turn this sheet over, please)

21. I failed _____

22. Reading _____

23. My mind _____

24. The future _____

25. I need _____

26. Marriage _____

27. I am best when _____

28. Sometimes _____

29. What pains me _____

30. I hate _____

31. This place _____

32. I am very _____

33. The only trouble _____

34. I wish _____

35. My father _____

36. I secretly _____

37. I _____

38. Dancing _____

39. My greatest worry _____

40. Women _____

SLEEP QUESTIONNAIRE

Please fill out as completely and accurately as possible.

Name_____ Age_____

Mailing address_____

Telephone number_____

Which nights of the week are you generally available as a subject?_____

Usual bedtime_____ Usual time of arising_____

Do you wake up spontaneously in the morning, or do you rely on an alarm or someone else to wake you?_____

If alarm, do you often wake before it goes off?_____

On an average, how long does it take for you to fall asleep?_____

Does it ever take you much longer than this?_____

If so, indicate how often (per month) and under what circumstances_____

_____

If you don't have to get up, say on Sunday morning, how long can you sleep at a stretch?_____

Upon arising, how long does it usually take you to be alert and wide awake?_____ How do you feel upon waking? (check one)

Disoriented___ Dazed___ Sleepy___ Groggy___ Tired___ So-so___

Mildly alert___ Alert___ Wide awake___ Energetic___

Do you ever wake in the middle of the night?_____ How often?_____

Under what circumstances?_____

How long does it take for you to fall asleep in a strange place?_____

In the last few years, have you ever had a stretch of days when it was hard for you to sleep?_____ If so, when, how long, and circumstances.

_____

_____

Are you a light, deep, or medium sleeper?_____

On waking in the morning, how often are you aware of having dreamed the preceding night?_____ In the past two years have you had bad dreams or nightmares?_____ Did they waken you?_____

Have you ever taken anything to help you sleep?_____

Do you remember the medication and dosage?_____

Have you ever taken anything to stay awake, say to cram for exams?_____

Do you remember the drug and the dosage?_____

Can you describe the effects?_____

Do you drink coffee, tea, or alcohol?_____ Amounts?_____

Effects?_____

When and where was your last physical checkup by a doctor?_____

_____ Results?_____

Have you ever had any surgery?_____ If so, where, when, and what for?_____

Have you ever been hospitalized for nonsurgical reasons?_____

If so, where, when, how long, what for, and out come?_____

_____

What is your general health now?_____

When was your last visit to a physician for any reason other than a general checkup?_____ Reason?_____ Outcome?_____

Have you ever had bad reactions to any drug or medication?_____

If so, name drug and describe reactions?_____

_____

Did you ever or do you now have any allergies?_____

If so, please describe?_____

How often do you engage in strenuous exersise?_____

Type of exercise?_____ Length of session?_____

Do you smoke?_____ How Much?_____

Do you take any drug or medicine?(pill, tablet, capsule, liquid, injection, etc.)_____ If so please describe?_____

_____

_____

Use below and back if you need additional space for answering any question or questions.

Best Available Copy

C.I. -- Form N2

Name_____ Age_____ Today's date_____

Home Address_____ Married?_____

Occupation_____ Last school grade reached_____

Directions: Put a circle around YES if you can answer yes to the question asked.
Put a circle around NO if you have to answer no to the question asked.
Answer all questions -- if you are not sure, guess.

1.	Have you ever had a headache?	YES	NO
2.	Do you frequently feel faint?	YES	NO
3.	Do you have hot or cold spells?	YES	NO
4.	Have you fainted more than twice in your life?	YES	NO
5.	Do strange people or places make you afraid?	YES	NO
6.	Do you often have spells of dizziness?	YES	NO
7.	Do you get all nervous and shaky when approached by a superior?	YES	
8.	Does the sight of blood make you want to drop down in a faint?	YES	NO
9.	Does your work fall to pieces when the boss or a superior is watching?	YES	NO
10.	Are you scared to be alone with no friends near you?	YES	NO
11.	Do you feel nervous or dizzy right at this moment?	YES	NO
12.	Do you always get orders and directions wrong?	YES	NO
13.	Does your thinking become completely confused when you have to do things quickly?	YES	NO
14.	Do you always sweat and tremble a lot during inspections or examinations?	YES	NO
15.	Do you wish that you always had someone at your side to advise you?	YES	NO
16.	Do you have to do things very slowly in order to be sure you are doing them right?	YES	NO
17.	Does it bother you to eat anywhere except in your home?	YES	NO
18.	Do you have an uncontrollable need to repeat the same disturbing actions?	YES	NO
19.	Is it always difficult for you to make up your mind?	YES	NO
20.	Do you usually feel cheerful and happy?	YES	NO
21.	Do you always have a bad time no matter what you are doing?	YES	NO
22.	Do you often feel miserable and blue?	YES	NO
23.	Does life usually look entirely hopeless?	YES	NO
24.	Are your emotions usually dead?	YES	NO
25.	Are you usually quiet and sad while at a party?	YES	NO
26.	Do you often wish you were dead and away from it all?	YES	NO
27.	Are you considered a nervous person?	YES	NO
28.	Do you have any unusual fears?	YES	NO
29.	Do you often have difficulty in falling asleep or staying asleep?	YES	NO
30.	Does every little thing get on your nerves and wear you out?	YES	NO
31.	Does worrying continually get you down?	YES	NO
32.	Did you ever have a nervous breakdown?	YES	NO
33.	Were you ever a patient in a mental hospital?	YES	NO
34.	Do you get out of breath long before anyone else?	YES	NO
35.	Do you have pains in the heart or chest?	YES	NO
36.	Does your heart often race like mad for no good reason?	YES	NO
37.	Do you often have difficulty in breathing?	YES	NO
38.	Are you often bothered by thumping of the heart?	YES	NO
39.	Do you often become suddenly afraid while you are thinking?	YES	NO
40.	Do you often shake or tremble?	YES	NO
41.	Are you often awakened out of your sleep by frightening dreams?	YES	NO
42.	Do you always become scared at sudden movements or noises at night?	YES	NO
43.	Do sudden noises make you jump and shake badly?	YES	NO
44.	Do you tremble or feel weak every time someone shouts at you?	YES	NO
45.	Are you keyed up and jittery every single moment?	YES	NO
46.	Do you have very disturbing or frightening thoughts that keep coming back in your mind?	YES	NO

47. Do you suffer badly from severe headaches? YES NO
48. Are you repeatedly bothered by severe itching? YES NO
49. Do you sweat a great deal even in cold weather? YES NO
50. Are you troubled by stuttering? YES NO
51. Have you at times had a twitching of the face, head or shoulders? YES NO
52. Were you a bed wetter between the ages of 8 to 14 years? YES NO
53. Do cold hands or feet trouble you even in hot weather? YES NO
54. Do you suffer from asthma? YES NO
55. Are you a bed wetter? YES NO
56. Are you a sleep walker? YES NO
57. Have you ever had a fit of convulsion? YES NO
58. Do pains in the back make it hard for you to keep us with your work? YES NO
59. Do you sometimes find yourself unable to use your eyes because of pain? YES NO
60. Is your body always in very bad condition? YES NO
61. Do severe pains and aches make it impossible for you to perform your duties? YES NO
62. Do you get spells of exhaustion or fatigue? YES NO
63. Do you wear yourself out with worrying about your health? YES NO
64. Do weak or painful feet make you miserable every single day? YES NO
65. Do you frequently get up tired in the morning? YES NO
66. Does pressure or pain in the head make it hard for you to perform your duties? YES NO
67. Are you always in poor health and unhappy? YES NO
68. Are you constantly too tired and exhausted to even eat? YES NO
69. Is your appetite good? YES NO
70. Do you constantly suffer from bad constipation? YES NO
71. Do you often suffer from an upset stomach? YES NO
72. Do you frequently get attacks of nausea (sick to your stomach)? YES NO
73. Do you suffer from indigestion? YES NO
74. Do you always have stomach trouble? YES NO
75. Do your stomach and intestines work badly? YES NO
76. Do pains in the stomach double you up after every meal? YES NO
77. Do you usually have trouble in digesting food? YES NO
78. Do you suffer badly from loose bowel movements? YES NO
79. Has any doctor ever told you that you had ulcers of the stomach? YES NO
80. Do people usually misunderstand you? YES NO
81. Do you have the feeling that people are watching you or talking about you in the street? YES NO
82. Have you usually been treated fairly? YES NO
83. Do you have the feeling of being watched while at work? YES NO
84. Do people usually pick on you? YES NO
85. Are you extremely shy or sensitive? YES NO
86. Are you easily upset or irritated? YES NO
87. Do you make friends easily? YES NO
88. Do you go all to pieces if you don't constantly control yourself? YES NO
89. Have you every been sent to reform school? YES NO
90. Have you ever gotten into serious trouble or lost your job because of drinking? YES NO
91. Have you been arrested more than three times? YES NO
92. Have you ever taken drugs regularly (i.e. morphine, methedrine, LSD)? YES NO
93. Do your enemies go to great lengths to annoy you? YES NO
94. Does it make you angry to have anyone tell you what to do? YES NO
95. Do you often drown sorrows in drink? YES NO
96. Do you always do things on sudden impulses? YES NO
97. Do people always lie to you? YES NO
98. Do you flare up in anger if you cannot have the things that you want right away? YES NO
99. Is the opposite sex unpleasant to you? YES NO
100. Do you always have to be on your guard with friends? YES NO
101. Do you often get into a violent rage? YES NO

Report to the Association for the Psychophysiological Study of Sleep, March 1969

LONG SLEEPERS AND SHORT SLEEPERS: PRELIMINARY RESULTS

Ernest Hartmann* Frederick Baekeland**
George Zwilling* Patrick How**

* Tufts University School of Medicine, Boston State Hospital
**Downstate Medical Center, State University of New York

This report presents results from portions of a large-scale psychological and physiological study of persons with unusual sleep requirements.

Notices were placed in New York and Boston newspapers asking for male subjects over 20 who always slept over nine hours or always slept under six hours per day

Over 400 respondents were studied and screened in three steps:

1) A sleep log form to be filled out for at least two weeks, a sleep history, the Cornell Medical Index, and the Rotter Incomplete Sentences Test were sent to subjects to be returned by mail.

2) Those subjects who "passed" i e whose sleep fell within the indicated ranges and who were relatively "normal" on the two tests, and had no serious medical illness were then asked to come in for a brief psychiatric interview and to take an MMPI.

3) Those considered free of psychosis or acute neurosis and whose MMPI included no scale value (except mf) two standard deviations above normal were given a longer (1-hour) psychiatric interview, took the California Personality Inventory (CPI), the Rod-and-Frame test, and had blood drawn for PBI

These subjects also had their sleep recorded (EEG, EOG, EMG) in the laboratory for a total of eight nights on which they slept their usual claimed length of time: two adaptation nights approximately one week apart, then four consecutive nights for the major analysis of sleep stages, then two non-consecutive nights for dream recall studies Wilkinson Vigilance tests were given after awakening as a partial check on whether the subjects were functioning normally or were sleep-deprived

Thus the physiological sleep data and the laboratory dream reports are being obtained on a relatively small group of eventually about 40 subjects -- ten aged 20-34 and ten aged 35-[illegible] in each sleep category -- while data from psychological tests and interviews are available on a much larger number Only the latter results are presented here

PRELIMINARY RESULTS

There were many differences, not unexpectedly, between the subjects who were screened out and those kept for physiological study The "rejected" short sleepers reported more awakenings during the night, for instance, than the "accepted" short sleepers

Long sleepers had significantly more dream recall than short sleepers, according to the sleep log reports

For the group as a whole, sleep variability was significantly correlated with measures of psychiatric impairment This is especially true of long sleepers under 35 and short sleepers over 35

MMPI: The long and short groups (total samples) were tested against each other, and each was tested against the male norms established by the MMPI test group Two scales clearly distinguished long from short sleepers at $p < .01$ The short sleepers scored higher on the L-scale indicating a greater tendency to want to appear normal or acceptable The long sleepers were higher on the Si-scale indicating a greater tendency to social withdrawal. Both of these differences agree entirely with results of the interviews

The means of both groups (total sample) were significantly higher than the male norms on most clinical scales This might be expected since the total sample included many subjects screened out on psychiatric grounds. Further analyses are being carried out on subgroups of each category.

CPI: (California Personality Inventory): Ns are small so far, since only subjects who are accepted by all other measures, and are being studied in the sleep laboratory, are given this test

Short sleepers score higher in social presence ($p < .05$) and tend to be higher in sociability, tolerance, and flexibility ($p < .10$). The overall profiles suggest that short sleepers are more socially adept or flexible and more dominant in their relations with others

Impressions from the Interview: Long sleepers often take 15-20 minutes to get to sleep, and also take a long time to awaken fully in the morning. They tended to be shy, slightly anxious or inhibited, mildly depressed, often passive They expressed many minor complaints about the laboratory They had a variety of social and psychological problems. Several men of around age 30 had had no sexual experience Several had been definitely depressed at one time Most were in some way unsure of themselves One clearly stated "I value the isolation of sleep" and another "I sleep a lot to get away from things"

As to vocation, the groups seemed to include a large proportion of unemployed men, sculptors, part-time student "hippies" It might be thought that men in these fields have shorter working hours, more time to sleep, and are merely taking advantage of this, but our data indicate that usually the subject was a long sleeper before he took up his present vocation or style of life

Short sleepers fell asleep quickly and usually described themselves as alert immediately upon awakening

They were all either employed full time (usually more) or in school full-time often going to school with a job on the side Several reported that they usually worked 70-80 hours per week Their histories often indicated that they had "become short sleepers" at 16-20 with increasing pressure on their time, but found they could manage easily on reduced sleep and even enjoy it, so that now they sleep short hours even on weekends and vacations Jobs included engineering, business, carpentry and contracting They seemed very sure of their job choices with none of the delay or indecisiveness of the long sleepers They complained little about any facet of the experiment.

As a rule the short sleepers appeared active, energetic, often athletic, cheerful, sure of themselves. They certainly manifested much less overt psychopathology than the long sleepers They gave the impression of being very normal and all-American .. occasionally perhaps too much so They are conformists in their opinions and career choices and generally show little interest in introspection. Some have mild compulsive traits. Typically their way of dealing with problems is to keep busy and to deny the problem in the hope that it will go away, "I don't let serious things go to my head" Most subjects were asked if there was anything at all about themselves they would like to change; the short sleepers usually answered in the negative Their life styles and character defenses might be characterized as efficient and often hypomanic.

Name _____ Date _____ Site _____ REM _____

	AGGRESSION	ANXIETY	URGENCY	SOCIAL AFFECTION	DEPRESSION	DISTRUST	QUIET	DETACHED
Slide 1		jittery ___	playful ___			suspicious___	quiet___	detached___
Slide 2	defiant ____ angry _____			warmhearted ____	sad ____			
Slide 3		fearful___	carefree___	affectionate___	regretful___			distant_____
Slide 4	rebellious _____	clutched up _____				skeptical___	placid ____	remote_____
Slide 5			witty ____	Kindly____	sorry____	dubious____	still___	
TOTAL	_____	_____	_____	_____	_____	_____	_____	_____

Slide 6

Dream active _____

You active _____

Dream busy _____

How vivid _____

Sleep depth _____

Individual adjectives are scored as follows: Much is scored as 3, little as 2, don't know as 1, and No as 0. Factor scores are obtained by summing the scores of the individual adjectives in the factor.

35

SLEEP PATTERNS OF LONG AND SHORT SLEEPERS

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Patrick Hoy* George Zwilling**

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The sleep of ten long sleepers (habitually sleep≥9 hrs.) aged 20-34 and eighteen short sleepers (habitually sleep<6 hrs.) ten of them ages 20-34 and eight of them 35-49, was studied for eight nights. Nights 1 and 2, a week apart, were for acclimatization, while nights 3-6 were consecutive. On nights 7 and 8, which were separated by at least two nights of uninterrupted sleep, Ss were awakened from all REMPs for dream reports. On nights 1-5 Ss slept their mean home sleep times as determined by sleep logs, while on night 6, to check on the possibility of partial sleep deprivation, short sleepers slept ad lib. On all nights, 10 minutes after awakening in the AM, Ss performed the Wilkinson vigilance test for ½ hour. Ss were rigorously screened both for medical and psychiatric normality, as well as for regularity of home sleep patterns.

Long vs. Short Sleepers: 20-34: Mean sleep times (av. of nights 3-5) of the two groups were 514.0 and 330.1 min. (8.57 and 5.50 hrs.). On an absolute basis, long sleepers accumulated more AW and stages REM and 2 sleep. On a percentage basis, they accumulated more REM sleep and short sleepers more stages 3, 4 and delta sleep. Long sleepers had longer interREMP intervals ($R_1 \rightarrow R_2$, $R_2 \rightarrow R_3$). Long and short sleepers did not differ in vigilance test performance. Long sleepers, in terms of interREMP intervals, seemed more sensitive to partial REM sleep deprivation.

Short Sleepers: 20-34 vs. 35-49: On both an absolute and percentage basis, older short sleepers accumulated more wakefulness, and they tended to have less stage 3 and delta sleep. They had shorter first REMP latencies. On the vigilance test they had a higher detection rate and a higher proportion of false reports, suggesting both better detection capacity and higher motivation.

The young short sleepers did not appear to be partially sleep deprived: no differences were found between their sleep patterns and vigilance test performance on night 6 and those on nights 3-5 or night 5. However, they did tend to sleep longer on night 6.

The older Ss did better on the vigilance test after night 6 than after nights 3-5. However, their first REMP latencies were longer on night 6 than on nights 3-5, and there was no difference between the values of any other sleep parameters on night 6 and those on nights 3-5 or night 5.

These results suggest that: (1) the sleep patterns of short sleepers become more fixed with age, (2) short sleepers are not partially sleep deprived, (3) both long and short sleepers have a similar (probably biologically determined) need for slow wave sleep which is rather fixed and, within limits, unrelated to time spent awake, (4) long sleepers have greater REM sleep requirements than short sleepers, possibly on a psychological basis.

S(20-34) vs. L(20-34): Mean of Nights 3, 4 and 5

RECORDED SLEEP PARAMETERS

		S(20-34)	L(20-34)	P(2-tailed t-test)
Min. First 3 Hours	AW	5.0± 3.7	10.6±11.9	n.s.
	REM	24.7± 7.0	20.9± 8.6	n.s.
	1	4.5± 4.2	4.1± 4.3	n.s.
	2	82.1±14.7	89.5±26.5	n.s.
	3	18.0± 6.2	15.6± 4.9	n.s.
	4	45.7±14.7	39.3±23.1	n.s.
	Δ	63.7±16.6	54.9±22.7	n.s.
Min. Whole Night	AW	11.3± 7.3	44.2±39.4	$<.05$
	REM	65.2±15.8	121.2±35.5	$<.001$
	1	8.1± 6.0	17.3±16.0	n.s.
	2	167.2±15.7	261.4±73.7	$<.01$
	3	25.0±10.0	22.5± 8.6	n.s.
	4	53.3±19.5	47.4±30.4	n.s.
	Δ	78.3±23.9	69.9±33.0	n.s.
	TST	330.1±27.7	514.0±55.8	
% Whole Night	AW	3.5±2.2	9.2±10.1	n.s.
	REM	19.5±3.6	23.6± 5.9	$.05<p<.10$
	1	2.5±1.8	3.1± 2.8	n.s.
	2	50.6± 7.1	50.0±11.5	n.s.
	3	7.5± 2.6	4.4± 1.8	.01
	4	16.4± 4.9	9.7± 7.1	$<.05$
	Δ	23.9± 7.1	14.1± 7.7	$<.01$
Sleep Latency (min.)		17.1±19.1	34.4±30.1	n.s.
1st REMP Latency		93.8±18.8	99.1±46.9	n.s.
$R_1 \rightarrow R_2$ (min.)		89.7± 7.0	107.9±23.0	$.05<p<.10$
$R_2 \rightarrow R_3$ (min.)		95.7±11.0	122.8±18.6	$<.01$

S(20-34) vs. S(20-34): Mean of Nights 3, 4 and 5

RECORDED SLEEP PARAMETERS

		S(20-34)	S(35-49)	P (t-tests)
% Whole Night	AW	3.3±2.4	8.4± 5.3	/.05 (2T)
	REM	19.5±3.7	20.4± 5.3	n.s.
	1	2.5±1.8	3.3± 2.4	n.s.
	2	50.6 ~~40.8~~±7.1	49.4±10.0	n.s.
	3	7.5±2.6	5.7± 2.1	.05/p/.10 (1T)
	4	16.4 ~~17.5~~±5.6	12.8±10.0	n.s.
	Δ	23.9 ~~23.0~~±6.9	18.5±10.3	.05/p/.10 (1T)
Min. Whole Night	AW	11.3± 7.3	26.2±16.4	/.05 (2T)
	REM	65.2±16.2	66.2±19.4	n.s.
	1	8.1± 6.0	8.4± 5.2	n.s.
	2	167.2±15.7	150.3±35.2	n.s.
	3	25.0±10.0	19.6± 7.2	n.s.
	4	53.3±19.5	42.2±33.9	n.s.
	Δ	78.3±23.9	61.8±34.8	n.s.
	TST	330.1±28.6	312.9±12.8	n.s.
Min. First 3 Hours of Sleep	AW	5.0± 3.7	10.4± 6.4	/.05 (2T)
	REM	24.7± 7.0	30.8±11.5	n.s.
	1	4.5± 4.2	6.5± 5.2	n.s.
	2	82.1±14.7	78.0±29.5	n.s.
	3	18.0± 6.2	14.8± 6.1	n.s.
	4	45.7±14.7	39.7±31.7	n.s.
	Δ	63.7±16.5	54.5±28.3	n.s.
Sleep Latency (min.)		17.1±19.1	27.1+37.8	n.s.
1st REMP Latency		93.8±18.8	70.4±17.2	.02 (2T)
$R_1 \rightarrow R_2$ (min.)		90.0±17.0	97.9± 7.0	n.s.
$R_2 \rightarrow R_3$ (min.)		95.7±11.0	97.9±	n.s.

MEAN OF NIGHTS 3-5

vs. NIGHT 6

		S(20-34)			S(35-49)		
		$\bar{X}$	N6	P	$\bar{X}$	N6	P
Sleep Latency		17.1±19.1	11.4±10.9	n.s.	27.1±37.8	20.6±27.8	n.s.
1st REMP Latency		93.8±18.8	94.2±29.0	n.s.	70.4±17.2	97.6±48.4	.05/p/.10
Min. in 1st 3 Hours of Sleep	AW	5.0± 3.7	8.4±14.4	n.s.	10.4± 6.4	9.8± 8.4	n.s.
	REM	24.7±20.9	29.2± 9.9	n.s.	30.8±11.5	28.5±14.2	n.s.
	1	4.5± 4.2	3.4± 4.0	n.s.	6.5± 5.2	8.3±10.2	n.s.
	2	82.1±14.7	75.4±18.0	n.s.	77.8±29.5	87.0±26.9	.05/p/.10
	3	18.0± 6.2	16.3± 7.6	n.s.	14.8± 6.1	13.5± 3.1	n.s.
	4	45.7±14.7	46.1±19.3	n.s.	39.7±31.7	34.0±25.9	n.s.
	Δ	63.7±16.6	62.6±21.6	n.s.	34.5±28.3	47.5±26.1	n.s.

VIGILANCE TEST RESULTS

1/2-Hour Test, Mean of Nights 3, 4, 5 [$\bar{X}$ (3-5)]

Proportion of Undetected Signals

		L	S	$\bar{X}$(3-5)	N6	
20-34	$\bar{X}$	.459	.497	.504	.533	20-34
	Sx	.180	.157	.165	.245	
	P	n.s.		n.s.		
All Ss	$\bar{X}$	.427	.390	.258	.431	35-49
	Sx	.182	.239	.256	.264	
	P	n.s.		$/$.05		

	S(20-34)	S(35-49)
$\bar{X}$	.497	.258
Sx	.157	.256
P	$/$.05	

False Reports (Undetected Signals & False Reports)

	L	S	$\bar{X}$(3-5)	N6	
$\bar{X}$	.323	.331	.328	.256	20-34
Sx	.317	.332	.339	.268	
P	n.s.		n.s.		
$\bar{X}$	.388	.456	.613	.409	35-49
Sx	.325	.343	.302	.378	
P	n.s.		n.s.		

	S(20-34)	S(35-49)
$\bar{X}$	.331	.613
Sx	.332	.302
P	.05$/p/$.10	

TOTAL SLEEP TIMES

Nights 3-5 and Night 5 vs. Night 6

	S (20-34)			S (35-49)		
	N5	N6	$\bar{X}$ (3-5)	N5	N6	$\bar{X}$ (3-5)
$\bar{X}$	330.8	377.5	330.1	333.2	316.4	312.9
Sx	26.5	63.4	28.6	21.4	61.0	12.8
P	.05/p/.10	.05/p/.10		n.s.	n.s.	

L(y) = L(20-34)
S(y) = S(20-34)
S(o) = S(35-49)

PARTIAL REM DEPRIVATION EFFECTS ON 2 NIGHTS OF REMP AWAKENINGS FOR DREAM REPORTING

$\Delta = \bar{X}(3\text{-}5) - \bar{X}(7\text{-}8)$

	$R_1 \rightarrow R_2$									$R_2 \rightarrow R_3$								
	$\bar{X}(3\text{-}5)$			$\bar{X}(7\text{-}8)$			Δ			$\bar{X}(3\text{-}5)$			$\bar{X}(7\text{-}8)$			Δ		
	L(y)	S(y)	S(o)	L(y)	S(y)	S(o)	L(y)	S(y)	S(o)	L(y)	S(y)	S(o)	L(y)	S(y)	S(o)	L(y)	S(y)	S(o)
$\bar{X}$	107.9	89.7	97.9	87.7	94.6	88.6	20.2	-4.9	9.3	122.8	95.7	97.9	89.3	79.0	63.4	33.5	16.7	34.5
Sx	23.0	7.0	7.0	28.5	16.2	15.5	39.2	16.1	21.2	18.6	11.0		14.4	20.3	16.6	10.3	21.6	20.4

Δ ($r_1 \rightarrow r_2$ vs. $r_2 \rightarrow r_3$) — L(y): n.s.; S(y): $/.01$ (2-T); S(o): $/.02$ (2-T)

$R_1 \rightarrow R_2$: $\bar{X}(3\text{-}5)$ vs. $\bar{X}(7\text{-}8)$ — L(y): $.05/p/.10$ (1-T); S(y): n.s.; S(o): n.s.

$R_2 \rightarrow R_3$: $\bar{X}(3\text{-}5)$ vs. $\bar{X}(7\text{-}8)$ — L(y): $/.001$ (2-T); S(y): $/.05$ (2-T); S(o): $/.01$ (2-T)

$R_1 \rightarrow R_2$: Δ — L(y) vs. S(y): n.s.; S(y) vs. S(o): n.s.

$R_2 \rightarrow R_3$: Δ — L(y) vs. S(y): $/.05$; S(y) vs. S(o): n.s.

Sleep Need: How Much Sleep and What Kind?

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ABSTRACT

Adult males who always sleep less than six hours or more than nine hours per day were studied. Over 400 were screened; smaller numbers had various psychological tests and psychiatric interviews, and finallly 29, free of overt medical or psychiatric pathology, were studied in the laboratory for 8 nights each of all-night polygraphic recording. Psychologically the short sleepers were efficient, hard-working, and somewhat hypomanic. The long sleepers tended to be anxious, depressed, or withdrawn. The two groups spent an almost identical amount of time - 75 minutes - in deep slow-wave sleep (stages 3-4), but the long sleepers had twice as much D-time (REM-time). It is suggested that there are two separate sleep requirements, a requirement for stage 3-4 sleep which is relatively constant across persons, and a requirement for D-time which is related to the personality and life-style of the individual.

We present here the results of a large scale psychological and physiological study of long and short sleepers -- persons who appear to require considerably more or less sleep than most of us.

The study was intended to answer at least two sets of questions. First of all the physiological question of what kind of sleep do long and short sleepers obtain and in what proportions. Now that we can classify mammalian sleep into two qualitatively different states, S (synchronized or non-REM sleep) and D (dreaming, desynchronized or REM sleep) it would be interesting to know whether certain quantities of one or the other are required by everyone, or whether one or the other is relatively dispensable. In man, S sleep is traditionally divided into stages 1 through 4; stage 4 comes earliest in the night and appears to be "deepest". Again it would be useful to know man's requirements for these different stages, and this could be studied by looking at extreme cases -- the long and short sleepers. Secondly there is the psychological question of what personalities, life styles, and psychodynamics characterize our two somewhat unusual groups of subjects: persons who habitually sleep less than 6 hours, and persons who sleep more than 9 hours every day.

Both the physiological and psychological data may give us clues to a more fundamental question -- what are the functions of sleep? One approach to studying the function of sleep is of course to investigate sleep deprivation. Although many such studies exist, they have not been very fruitful in elucidating basic functions. In this study we hope to take advantage of an experiment in nature by studying persons at two ends of what is presumably a continuous sleep need distribution. The physiological results may tell us what portions of sleep are perhaps needed equally by everyone and thus presumably fulfill some basic biological function and what portions are either dispensable or are needed in very differing amounts; the psychological studies can give us some clue as to the kinds of persons or the kinds of daytime activity and style which are associated with these differing sleep needs.

With these aims in mind, we attempted to find populations of persons who truly had different sleep needs; this may be different from merely per-

sons who obtain different amounts of sleep. There are obviously insomniac persons who only sleep 5 or 6 hours a night but complain of this and seek treatment. Such insomniacs have been the subjects of other studies, but were not of interest to us here, since they probably required more sleep than they were getting. Likewise it is easy to find students and others who sleep only a few hours a night for weeks but then "catch up" on Sundays, after an exam, etc. Here again one cannot say that their sleep need is actually low.

Method

Subject selection took place in a series of steps, at each step some subjects were eliminated from further study but the data obtained was kept for later evaluation.

Notices were placed in major daily newspapers in Boston and New York asking for males over 20 who always slept over 9 hours or always slept under 6 hours per day. The notice mentioned that subjects would be paid for participation in a medical study of sleep.

Over 400 persons responded to the ads and called one of the two participating sleep laboratories. Of these, about one-third were eliminated during a telephone conversation on the basis of their having misunderstood the ad, etc. A set of forms was then mailed out to the remaining 260 subjects. These forms consisted of 1) a sleep log to be filled out daily for at least 3 weeks; this simply asked, each day, for the time subject went to bed, time he arose, hours he estimates he slept, any naps, and any dreams. 2) A sleep history form asking various questions about habitual length of sleep, whether the subject ever needed to catch up on sleep, how long it took him to get to sleep and to feel fully awake in the morning, and also asking questions about medical illnesses, medication, alcohol, drugs etc. 3) The Cornell Index, a form consisting of 101 simple questions about medical and psychosomatic conditions to be answered true or false, and 4) the Rotter incomplete sentences test -- a relatively quantitative and easily scorable psychological test.

At this stage, screening purely by mail, subjects were eliminated from further study under any of the following conditions: if their home sleep log showed a mean sleep time that was not under six or over nine

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hours per day, or if two or more nights in two weeks that did not fall into the indicated range (over 9 or under 6 hours); if sleep history showed a marked variation in sleep times, or a pattern of long or short sleep that had not persisted for at least 6 months; if a serious medical or psychiatric illness was present; or if they scored 8 or more on the Cornell Index or 130 or more on the Rotter test. In other words, subjects were not studied further who either showed an unstable pattern of long and short sleep, or who showed evidence of considerable medical, psychosomatic, or psychiatric impairment. Of 227 subjects who returned these forms 52 were both accepted and actually appeared for further study.

These subjects came to the laboratory and were given a 20-minute psychiatric interview and took an MMPI test. Subjects were not studied further if they scored two standard deviations above normal on any MMPI scale except Mf*. Psychiatric interview explored personality characteristics briefly, and also investigated any areas that appeared problematic on the basis of the previous psychological tests. Thus the typical sleep pattern was further clarified, some family sleep history was obtained, further drug history was obtained as we wished laboratory study subjects to be as drug-free as possible, and the laboratory studies were explained to subjects so that any questions or fears about them could be discussed. Subjects were eliminated on the basis of the interview if they were judged to be psychotic, to be grossly unreliable, or to be in a rapidly changing state such as an acute neurosis, or if they were taking drugs or medication of any kind except occasional alcohol and nicotine.

After these procedures 38 subjects were accepted for laboratory study, and 29 actually appeared and completed the entire laboratory procedure (see below). In addition to laboratory sleep, each of these 29 subjects was given a longer (at least one hour) psychiatric interview, and took the California Personality Inventory (CPI).

Each then slept in the laboratory for eight nights: The first two nights, spaced about one week apart were considered adaptation nights. Nights 3, 4, 5, and 6, about one week after night 2, were consecutive

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* It has been found that high Mf scales are now exceedingly common among young male subjects in the university student and post-student groups.

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nights in the laboratory. On nights 3, 4, and 5 subjects were given their usual indicated sleep time, but on night 6 were allowed to sleep as long as they wished; this gave us an opportunity to study changing patterns over the four nights and would allow us to pick up any signs that the short sleepers were becoming sleep deprived over the four nights. Shortly after awakening, on nights 1 through 6, subjects took a 30 minute Wilkinson Vigilance Task (14, 15) a test especially sensitive to sleep loss, to determine morning functioning on such a test and again to pick up any possible developing sleep deprivation.

Nights 7 and 8 were spaced about one week apart. These were dream recall nights which will not be discussed in this paper.

Results

We had hoped, in addition to the psychological data on a large number of subjects, to find 10 laboratory subjects in each of four groups: young (age 20-34) long sleepers, young short sleepers, older (35-49) long sleepers and older short sleepers. It proved almost impossible to obtain subjects in the older long-sleep group; only one was actually studied in the laboratory. A number of subjects originally applied, but were all eliminated for various reasons during the screening. We considered lowering the sleep cut-off point from 9 hours to 8½ hours but found this would still not obtain subjects. It may be that there really are no persons over 35 who routinely sleep 9 hours a night; certainly there did not appear to be many. However, it is also possible that such persons simply were not very interested in taking part in experimental studies. For a number of obvious reasons, including financial status, there is more interest in such studies among the 20-34 year old group. In any case, we have solid data for the four groups for the psychological screening tests, but for only 3 groups for analysis of the physiological sleep data -- 10 young short sleepers, 8 older short sleepers, and 10 young long sleepers.

The interpretation of the psychological studies and interviews is quite complex, and will be reported in more detail elsewhere. We shall summarize these results briefly, and then concentrate on the physiological sleep results. Our chief focus here will be in presenting results

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on the long vs. the short sleepers, but we will also present data comparing the older and younger short sleepers.

In the psychological tests, long and short sleepers could be compared at the various stages in our screening procedure. Comparing the large groups who filled out the original sleep histories and Cornell Indices, there was such great variability in both the long and short sleeper groups that no significant results were obtained. Certain differences did emerge between the smaller groups remaining after screening.* On the MMPI test short sleepers scored significantly higher ($p < .01$) than long sleepers on the L-scale, indicating a greater tendency to want to appear normal or acceptable. Long sleepers scored significantly higher ($p < .01$) on the Si-scale, indicating a greater tendency towards social "introversion" or withdrawal. On the California Personality Inventory short sleepers scored higher ($p < .01$) on scales indicating social presence, sociability, and flexibility. This and the overall CPI profile showed the short sleepers to be more socially adept and more dominant in their relationships with others.

Our summaries of the interviews and histories showed the following: short sleepers were all either employed full-time -- often more than full-time -- or in school full-time -- and often both. Several reported working 70-80 hours per week. Histories indicated that they had usually started sleeping their short hours around age 16-18, with increasing pressures from school and work, but unlike most other persons had found that they could do it and manage easily and even enjoy getting shorter amounts of sleep than previously. The vocations of the short sleepers included engineering, business, carpentry, and contracting, and the ones still in school were often studying engineering, business, and economics. The short sleepers seemed quite confident about their job or school choices with relatively little hesitation or vacillation; similarly, they took the sleep studies completely in their stride, with no complaint or worries about the experimental conditions. They were generally somewhat conformist and establishment-oriented in their job choice and their opinions.

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* The results that follow are based only on the group of 29 subjects who had the long interviews, the MMPI and the CPI.

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Psychologically, they appeared overall to be a successful and relatively healthy bunch with very little overt psychopathology, though some had mild compulsive traits; however, their entire life style involved keeping busy and avoiding psychological problems rather than facing them. Several of them asked about reactions to stress or difficulties, made statements such as "I don't let my worries go to my head." Thus insofar as there was pathology in this group it was in the direction of hypomania, and reliance on the mechanisms of denial, avoidance, and keeping busy.

Long sleepers included a greater variety of professions and interests than the short sleepers. Several of the men were unemployed, but several held responsible jobs in a number of areas; several were sculptors or part-time students and a few could be described as "hippies". One might think that their long sleep was merely a result of their having less strenuous working hours, but histories indicate again that usually the pattern of long sleep was established in late childhood or adolescence, and always preceded the current work pattern or life style. Long sleepers appeared less conformist in their views than the short sleepers and included some individuals who were quite creative in their work. Although subjects with severe psychiatric pathology were screened out, the remaining long sleeper group nonetheless showed a great variety of psychological and social problems. They tended to be shy, some were mildly depressed, some showed considerable anxiety in the interview. Almost all showed evidence of some inhibition in the spheres of sexual or aggressive functioning. They also had a number of minor medical and psychosomatic problems, and they frequently tended to complain about the experiment and the occasional noises in the sleep rooms, drafts, etc. It is hard to characterize them psychologically as a group, but they certainly included cases of depressive reactions, mild anxiety neuroses, and neurasthenia. Several but not all of them consciously placed great value on sleep, and even saw it as an escape from a somewhat painful waking life. One said "I value the isolation of sleep" another said "I sleep a lot to get away from things."

The results of the laboratory sleep studies are presented in Tables I, II, and III. Data are presented as means and standard deviations for uninterrupted nights 3, 4, and 5 on all subjects in the three groups -- young long sleepers, young short sleepers, and older short sleepers. It

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can be seen that the short sleepers averaged 5½ hours of sleep per night, while the long sleepers averaged slightly over 8½ hours of actual EEG sleep, though they all spent at least 9 hours in bed. The most striking result in the entire study, clearly evident in Table I, is that despite the great differences in total sleep time between long and short sleepers, the two groups spent almost identical amounts of time in slow-wave sleep -- stages 3 and 4 of sleep. The actual amount -- about 75 minutes -- is quite average for subjects in our laboratories. If only the two groups of age 20-34 are compared, (since age is known to affect slow-wave sleep), the short sleepers actually spend several minutes more per night in slow-wave sleep than do the long sleepers. Obviously the other portions of sleep make up the great difference in total sleep between the long and short sleepers; the difference is especially marked in time spent in the D-state -- 121 minutes in the long sleepers vs. 65 minutes in the short sleepers. These values fall neatly, almost equidistantly, on either side of our mean normal values of 95-100 minutes. The long sleepers also spent more time in stage 2, and more time awake.

When these figures are expressed as percentages of total time in bed (Table II), slow-wave sleep of course occupies a significantly higher percentage of total time in the short sleepers than in the long sleepers, whereas D-time percent does not differ greatly.

A question of interest might be whether the much higher D-time in the long sleepers is obtained as a result of more D-periods, longer D-periods, or both. Table III indicates that both were true: Although the S-D cycle is longer in the long sleepers their longer night of sleep gives them significantly more D-periods than the short sleepers, but in addition the long sleepers have somewhat longer individual D-periods.

As expected from the subjective reports, the long sleepers not only spent slightly more time awake than the short sleepers, but had somewhat longer sleep latency, and more awakenings during the night (Table III). However there was great variability on these measures.

The number of eye-movements per unit time (called REM-density) is sometimes taken as a measure of the "intensity" of the D-periods; situations such as recovery from D-deprivation are characterized by a high REM-density; also, reports of vivid, active dreams come from D-periods with a high REM-density (2). Table III indicates that the long sleepers

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showed greater REM-density within D-periods than the short sleepers. Thus the long sleepers cannot be said to have long but less intense D-periods; if anything their D-periods are even more intense than those of the short sleepers.

Comparison of the older with the younger short sleepers reveals nothing very unexpected: the older subjects spent more time awake, and slightly less time in slow-wave sleep. This agrees with the effects of age reported in unselected groups (12). In addition the older subjects had a lower D-latency; the significance of this is unclear, but it may be related to the somewhat lower slow-wave sleep time in the older subjects, since sleep before the first D-period is almost entirely composed of slow-wave sleep, and it is known that older subjects have reduced slow-wave sleep time (12).

Detailed comparisons of nights 3-5 with night 6 were made but can only be summarized here: there were no changes in sleep stages on night 6, suggesting that the short sleepers had not become deprived during their consecutive nights in the laboratory. Vigilance tests also showed no change that could be interpreted as sleep deprivation.

Discussion

First of all there is the question of whether we have truly studied groups of subjects with differences in sleep need. We believe we have done everything possible -- obtaining careful sleep histories, medical histories, current sleep logs, etc., and obtaining multiple consecutive laboratory sleep studies with an opportunity to look into possible sleep deprivation effects -- so that we can most probably rule out the possibility that the short sleepers really needed more sleep but were chronically sleep deprived. In fact, unless the short sleepers were consistently lying to us, and perhaps taking daily home naps while on the sleep study, we do not see any reasonable alternative to postulating a reduced sleep need. For the long sleepers, it is more difficult to ascertain absolutely that they needed their 9 hours of sleep and could not have gotten along on less. Here we relied on the interviews, and reports on the various questionairres and history forms. Each long sleeper stated that on various occasions he had tried sleeping less found it uncomfort-

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able, and felt that it interferred with his functioning. Therefore, though we consider it unlikely, it still remains a slight possibility for the long sleepers, and a very remote possibility for the short sleepers, that they actually had average sleep needs and were merely obtaining unusual amounts of sleep.

Our most basic finding -- the identical and normal amount of time spent in slow-wave sleep in the two groups, and the very different amounts of D-time -- are consistent with a report on two short sleepers by Jones and Oswald (8) and with a study by Webb and Agnew on college students who reported less extreme long or short sleep (10). But what does this mean, in terms of sleep need, and factors which might affect it?

One way to characterize the groups overall might be to say that the long sleepers are poorer sleepers than the short sleepers; they clearly spend more time awake during the night, have more awakenings, and on interview generally report that their sleep is not quite so deep or satisfactory, and that they do not feel as refreshed in the morning as the short sleepers. Qualitative aspects of the EEG records also appear to support these differences: The short sleepers provide "easy to score" records: the S and D periods are well demarcated, there is very little ambiguous, hard-to-score time and there are not a great many shifts back and forth between stages of sleep. The long sleepers show not only more awakenings but more stage shifts, and often more ambiguous stretches of record as well. The long sleepers resemble various groups of mildly anxious or depressed subjects studied in our laboratory and others (4), while the short sleepers fall at the opposite extreme.

Comparing our groups with two groups studied by Monroe whom he categorized as "good sleepers" and "poor sleepers" (9), it appears that his "poor sleepers" resemble our long sleepers psychologically rather than our short sleepers, even though his "poor sleepers" were insomniac and obtained less than average sleep times.

Are the long sleepers, then, merely "well-compnesated insomniacs?--people who resemble insomniacs psychologically and who physiologically tend to sleep poorly in some senses (many awakenings, many stage shifts, long sleep latency) but who are able to compensate for this inefficient sleep by remaining asleep for a very long time?

In our view this is a partial but insufficient explanation for our

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data. If our EEG tracings can give us any indication as to what may be important parts of sleep, we might look at first at the deep, slow waves of stages 3 and 4 normally occurring within the first hours of sleep. We have noted that the long sleepers obtain normal amounts of stages 3 and 4. If they are "compensated insomniacs" unable to obtain these slow waves efficiently we might expect the slow-wave sleep to occur later, or spread out over the entire night. However, this is not the case; the long sleepers concentrate their slow-wave sleep early in the night as do normal and short sleepers. Then we might examine the D-periods. A night of sleep is so arranged that the additional later hours of sleep provide a great deal of D-time, but the long sleeper does not stop when he has accumulated a normal quota of D-time or of phasic events; his night contains roughly twice as much D-time and three times as many rapid eye movements within D-periods as the night of the short sleeper. The possibility must be considered that the long sleeper is not trying inefficiently to get the usual sleep, but actually requires more of a certain kind of sleep, namely D-time.

Our view, derived from this study and other related sleep investigations, is that there are two separate functions fulfilled by sleep, and accordingly two separate sleep needs. First, a need for slow-wave sleep, which appears to be relatively constant across all subjects; our guess is that this need has something to do with physical restoration. One of the independent variables found to alter the amount of slow-wave sleep is exercise; increased exercise levels are followed by increased slow-wave sleep in man (1) and in the cat (7). Human growth hormone (HGH) secretion normally shows one or two peaks early in the night corresponding to the times when most stage 3, 4 sleep occurs (10, 11). When subjects switch to daytime sleep, the peak switches as well, indicating that HGH is probably secreted specifically during slow-wave sleep (10). This again suggests an anabolic or physically restorative function for slow-wave sleep.

Secondly we believe there is a need for D-time. (We base this partly on numerous human and animal studies of D-deprivation; on the basis of the present study alone, an alternative hypothesis would be that only SWS is needed.) The need for D shows considerable variation from individual to individual, and may be related to personality and psychological state.

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From the present correlative study we cannot firmly derive any causative explanations, but a plausible hypothesis is that the life style or personality of the long sleeper is associated with a greater requirement for D-time. We have suggested previously, on the basis of long-term sleep studies in hospitalized patients, that higher D-times were found at times of psychic pain or psychic disequilibrium with changing defense patterns (4, 6). Likewise we have found that women, and especially women with premenstrual tension, have higher D-times during the premenstrual phase of their cycle, a time characterized by irritability, depression and anxiety, and unstable defense patterns (3). Certainly the long sleeper is relatively anxious and depressed, and his life style involves change and worry.

On the other hand we have found that one group of patients who consistently function on little sleep and very low D-times are manic patients (5). The manic phase of illness is of course characterized by extreme avoidance of psychic pain and distress. The short sleepers show a milder form of the physiological sleep pattern we have found in mania, and in fact, as mentioned, the short sleepers are a bit hypomanic: although they are efficient and accomplish a great deal they tend to deal with problems by keeping busy, and by denial. Thus both between subjects and within subjects a pattern of pain, anxiety, or shifting defensive patterns may require more D-time at night.

In summary, then, we are suggesting two separate sleep needs, and two separate sleep functions to fulfill these needs -- a predominantly anabolic and physically restorative function fulfilled by SWS, and another perhaps more psychological restorative function fulfilled by the D-state.

TABLE I: Sleep Patterns of Long and Short Sleepers

Minutes Spent in Each Stage (Mean ± Standard Deviation)

	LONG SLEEPERS (Age 20-34)	SHORT SLEEPERS (Age 20-34)	SHORT SLEEPERS (Age 35-49)
Awake	44.2 (±39.4)	11.3 (± 7.3)*	26.2 (±16.4)+
Stage 1	17.3 (±16.0)	8.1 (± 6.0)	8.4 (± 5.2)
Stage 2	261.4 (±73.7)	167.2 (±15.7)**	150.3 (±35.2)
Stage 3	22.5 (± 8.6)	25.0 (±10.0)	19.6 (± 7.2)
Stage 4	47.4 (±30.4)	53.3 (±19.5)	42.2 (±33.9)
SWS (3 + 4)	69.9 (±33.0)	78.3 (±23.9)	61.8 (±34.8)
D-state	121.2 (±35.5)	65.2 (±15.8)***	66.2 (±19.4)
Total Sleep	514.0 (±55.8)	330.1 (±27.7)***	312.9 (±12.8)

*Significantly different from long sleepers, $p < .05$; **$p < .01$; ***$p < .001$ (t-test, two-tailed)

+Significantly different from young short sleepers, $p < .05$. (t-test, 2 tailed)

TABLE II: Sleep Patterns of Long and Short Sleepers

Percentages of Total Time in Bed Spent in Each Stage
(Mean ± Standard Deviation)

	LONG SLEEPERS (Age 20-34)	SHORT SLEEPERS (Age 20-34)	SHORT SLEEPERS (Age 35-49)
Awake	9.2 (±10.1)	3.3 (± 2.4)	8.4 (± 5.3)+
Stage 1	3.1 (± 2.8)	2.5 (± 1.8)	3.3 (± 2.4)
Stage 2	50.0 (±11.5)	50.6 (± 7.1)	49.4 (±10.0)
Stage 3	4.4 (± 1.8)	7.5 (± 2.6)**	5.7 (± 2.1)
Stage 4	9.7 (± 7.1)	16.4 (± 4.9)*	12.8 (±10.0)
SWS (3 + 4)	14.1 (± 7.7)	23.9 (± 5.6)**	18.5 (±10.3)
D-state	23.6 (± 5.9)	19.5 (± 3.7)	20.4 (± 5.3)

*Significantly different from long sleepers, $p < .05$; **$p < .01$ (t-test, two-tailed)

+Significantly different from young short sleepers, $p < .05$ (t-test, 2 tailed)

TABLE III: Sleep Patterns of Long and Short Sleepers

Other Sleep Characteristics (Mean ± Standard Deviation)

	LONG SLEEPERS (Age 20-34)		SHORT SLEEPERS (Age 20-34)		SHORT SLEEPERS (Age 35-49)	
No. of awakenings per night (surrounded by sleep)	16.8	(± 9.8)	12.9	(±11.8)	15.5	(± 7.4)
Sleep Latency (min)	34.4	(±30.1)	17.1	(±19.1)	27.1	(±37.8
D-Latency (min)	99.1	(±46.9)	93.8	(±18.8)	70.4	(±17.2)+
First cycle length (onset D_1 to onset D_2) (min)	107.8	(±23.4)	89.3	(±17.3)	100.0	(± 7.4)
Second cycle length (onset D_2 to onset D_3) (min)	122.7	(±19.0)	93.9	(±11.6)**	97.9	(±11.0)
No. of D-periods	4.5	(± 0.9)	3.2	(± 0.8)**	3.2	(± 0.7)
Mean D-period Length (min)	28.7	(± 6.6)	22.6	(± 6.2)	22.7	(± 6.6)
Mean REM-density	0.179	(± 0.083)	0.114	(± 0.054)*	0.128	(± 0.057)

* Significantly different from long sleepers, $p < .05$; ** $p < .01$ (t-test, two-tailed)

\+ Significantly different from young short sleepers, $p < .05$ (t-test, two-tailed)

REM-density is expressed as the number of 3-second epochs within D-periods containing an eye movement divided by the total number of 3-second epochs within D-periods, times 100, i.e., percent of 3-second epochs containing eye movements.

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TABLES

TABLE 1

THE NUMBER OF SUBJECTS FOR EACH SET OF DATA

	LONG, YOUNG	LONG, OLD	SHORT, YOUNG	SHORT, OLD
Cornell Index	92	24	61	49
Sleep Questionairre	92	24	61	49
Rotter Incomplete Sentences	92	24	61	49
Minnesota Multi-phasic Personality Inventory	18	6	15	12
Interview	18	6	15	12
Wilkinson Vigilance Task	10	1	10	8
Adjective Check List	10	1	10	8
California Psychological Inventory	10	1	10	8
Interview				
Physiological Sleep Data	10	1	10	8

TABLE 2

ANOVA Large Group Both accepted & rejected
All subjects Boston & N.Y.

Var. 15 Sunday Sleep Sig. at greater than .01
Rows (L vs S) Long sleepers sleep longer on sundays than short sleepers do.

Var. 22 Dream depth Sig, between .10 & .05

Columns (Y vs. O) Young sleepers report more dreams than long sleepers.

ANOVA Large Group Accepted seperated from Rejected
All subjects Boston & N.Y.

Var. 15 Rejected Sunday Sleep Sig..at greater than 1%
Rows (L vs. S) Long rejected sleep longer than short rejected.

Var. 15 Accepted Sunday Sleep Sig. at greater than 1%
Rows (L vs. S) Long accepted sleep longer than short accepted.

Var. 18 Rejected Night Waking Sig. between .10 & .05
Columns (Y vs O) Old sleepers wake up more frequently during the nite.

Var. 21 Rejected, Sleep Depth Sig. Between.10 &.05
Rows [illegible] (LvsS) Rejected long subjects sleep deeper than rejected shorts.

Var. 22 Rejected Dream Reoorts Sig. between .10 &.05
Rows (Lvs S) Long rejected report more dreams than short rejected.

Var. 24 Rejected Sleep Pill Sig between .10 & .05
Columns (Y vs O) Rejected old subjects report taking more sleeping pills than rejected young.

Var. 25 Rejected Wake Pill Sig. between .10 & .05
Columns (Y vs O) Rejected young sleepers report taking more wake pills than the rejected old sleepers .

TABLE 2

ANOVA Small Group Accepted included with Rejected
All subjects Boston & N.Y. who have taken MMPI

Var. 1 MMPI Lscale Sig. between .25 & .10
rows (L&S) Short sleepers have higher scores on L scale than the long sleepers.

Var. 13. MMPI Si scale Sig. between .25 &.10
Rows (1 vs. S) Long sleepers have higher scores than short sleepers.

ANOVA Small Group Accepted seperated from Rejected
All Subjects with MMPIs Boston & N.Y.

Var. 1 Accepted L Scale Sig. at 5%
Rows (L vs S) Short sleepers have higher scores than long sleepers.

Var. 5 Rejected D scale Sig. between .25 & .10
Rows Y vs. O.) Old sleepers have higher scores than young ones.

Var. 6 Rejected Hy scale Sig. between .25 & .10
Rows + Columns The young short sleepers have highest scores.

Var. 11 Sc scale. Rejected Sig. between .10 & .05
Rows (L vs S) Long sleepers have higher scores than short ones.

Var. 11 Rejected Sc scale Sig. between .10 & .05
Rows + Columns The Old Long sleepers have highest scores.

Var. 13 Accepted Si scale Sig. between .25 &.10
Rows (L vs S) Long sleepers have higher scores than short sleepers.

TABLE 1

VIGILANCE TEST RESULTS

1/2 Hour Test, Mean of Nights 3, 4, 5 [$\bar{X}$ (3-5)]

Proportion of Undetected Signals

		L	S	$\bar{X}$(3-5)	S N6	
20-34	$\bar{X}$	.459	.497	.504	.533	20-34
	Sx	.180	.157	.165	.245	
	P	n.s.		n.s.		
All Ss	$\bar{X}$	.427	.390	.253	.431	35-49
	Sx	.182	.239	.256	.264	
	P	n.s.		$<$.05		

	S(20-34)	S(35-49)
$\bar{X}$	.497	.253
Sx	.157	.256
P	$<$.05	

False Reports — Undetected Signals & False Reports

	L	S	$\bar{X}$(3-5)	N6	
$\bar{X}$	.323	.331	.328	.256	20-34
Sx	.317	.332	.331	.260	
P	n.s.		n.s.		
$\bar{X}$	.380	.456	.613	.409	35-49
Sx	.325	.342	.302	.379	
P	n.s.		n.s.		

	S(20-34)	S(35-49)
$\bar{X}$	.331	.613
Sx	.332	.302
P	.05/p/.10	

TABLE

RESULTS of MOOD ADJECTIVE CHECK LISTS
Long vs. Short Sleepers

Measure	Aggression	Anxiety	Urgency	Social Affection	Depression	Distrust	Quiet	Detached
Means of the First D-periods	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.
Means of All D-periods (both Recall Nights)	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.
Trends of Both Nights	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Not Sig.	Sig. at $<.05$ Level	Not Sig.

TABLE 6 : Sleep Patterns of Long and Short Sleepers

Minutes Spent in Each Stage (Mean ± Standard Deviation)

	LONG SLEEPERS (Age 20-34)	SHORT SLEEPERS (Age 20-34)	SHORT SLEEPERS (Age 35-49)
Awake	44.2 (±39.4)	11.3 (± 7.3)*	26.2 (±16.4)+
Stage 1	17.3 (±16.0)	8.1 (± 6.0)	8.4 (± 5.2)
Stage 2	261.4 (±73.7)	167.2 (±15.7)**	150.3 (±35.2)
Stage 3	22.5 (± 8.6)	25.0 (±10.0)	19.6 (± 7.2)
Stage 4	47.4 (±30.4)	53.3 (±19.5)	42.2 (±33.9)
SWS (3 + 4)	69.9 (±33.0)	78.3 (±23.9)	61.8 (±34.8)
D-state	121.2 (±35.5)	65.2 (±15.8)***	66.2 (±19.4)
Total Sleep	514.0 (±55.8)	330.1 (±27.7)***	312.9 (±12.8)

*Significantly different from long sleepers, $p < .05$; ** $p < .01$; *** $p < .001$ (t-test, two-tailed)

+Significantly different from young short sleepers, $p < .05$. (t-test, two-tailed)

TABLE 7 : Sleep Patterns of Long and Short Sleepers

Percentages of Total Time in Bed Spent in Each Stage
(Mean ± Standard Deviation)

	LONG SLEEPERS (Age 20-34)		SHORT SLEEPERS (Age 20-34)		SHORT SLEEPERS (Age 35-49)	
Awake	9.2	(±10.1)	3.3	(± 2.4)	8.4	(± 5.3)+
Stage 1	3.1	(± 2.8)	2.5	(± 1.9)	3.3	(± 2.4)
Stage 2	50.0	(±11.5)	50.6	(± 7.1)	49.4	(±10.0)
Stage 3	4.4	(± 1.8)	7.5	(± 2.6)**	5.7	(± 2.1)
Stage 4	9.7	(± 7.1)	16.4	(± 4.9)*	12.8	(±10.0)
SWS (3 + 4)	14.1	(± 7.7)	23.9	(± 5.6)**	18.5	(±10.3)
D-state	23.6	(± 5.9)	19.5	(± 3.7)	20.4	(± 5.3)

*Significantly different from long sleepers, $p < .05$; ** $p < .01$ (t-test, two-tailed)

+Significantly different from young short sleepers, $p < .05$ (t-t[illegible], two-tailed)

TABLE 8 : Sleep Patterns of Long and Short Sleepers

Other Sleep Characteristics (Mean ± Standard Deviation)

	LONG SLEEPERS (Age 20-34)		SHORT SLEEPERS (Age 20-34)		SHORT SLEEPERS (Age 35-49)	
No. of awakenings per night (surrounded by sleep)	16.8	(± 9.8)	12.9	(±11.8)	15.5	(± 7.4)
Sleep Latency (min)	34.4	(±30.1)	17.1	(±19.1)	27.1	(±37.8)
D-Latency (min)	99.1	(±46.9)	93.8	(±18.8)	70.4	(±17.2)+
First cycle length (onset D_1 to onset D_2) (min)	107.8	(±23.4)	89.3	(±17.3)	100.0	(± 7.4)
Second cycle length (onset D_2 to onset D_3) (min)	122.7	(±19.0)	93.9	(±11.6)**	97.9	(±11.0)
No. of D-periods	4.5	(± 0.9)	3.2	(± 0.8)**	3.2	(± 0.7)
Mean D-period Length (min)	28.7	(± 6.6)	22.6	(± 6.2)	22.7	(± 6.6)
Mean REM-density	0.179	(±0.003)	0.114	(± 0.054)*	0.128	(± 0.057)

*Significantly different from long sleepers, $p < .05$; ** $p < .01$ (t-test, two-tailed)

+Significantly different from young short sleepers, $p < .05$ (t-test, two-tailed)

REM-density is expressed as the number of 3-second epochs within D-periods containing an eye movement divided by the total number of 3-second epochs within D-periods, times 100, i.e., percent of 3-second epochs containing eye movements.

TABLE 9

RAW DATA AND REM DENSITY

(For Boston Subjects Only)

SHORT SLEEPERS	RAW DATA: Total No. 3 sec. REM Intervals / Total Number Pages			REM DENSITY: Total No. 3 sec. REM Intervals / (Total Number Pages)(10)		
NAME	NIGHTS			NIGHTS		
	3	4	5	3	4	5
L. Burke	194/155	270/139	239/187	.125	.194	.127
C. Greenbaum	196/168	154/134	170/135	.116	.114	.125
J. Jacobson	190/121	159/75	382/157	.157	.212	.243
R. Japinga	No record	234/157	182/189	—	.149	.096
P. Minar	37/110	110/156	49/158	.033	.070	.031
K. Nagai	161/140	235/125	294/120	.115	.188	.227
[illegible] Nolan	38/113	18/43	86/140	.077	.041	.061
B. Tugent	129/126	97/140	85/23[illegible]	.102	.069	.035
D. Scarbeau	152/141	114/185	122/168	.107	.061	.072
C. Scott	119/195	93/167	96/183	.061	.055	.052
[illegible] V. Williams	217/235	184/198	120/112	.092	.092	.107

TABLE 9 (continued)

RAW DATA AND REM DENSITY

(For Boston Subjects Only)

LONG SLEEPERS	RAW DATA: Total No. 3 sec. REM Intervals / Total Number Pages			REM DENSITY: Total No. 3 sec. REM Intervals / (Total Number Pages)(10)		
NAME	NIGHTS			NIGHTS		
	3	4	5	3	4	5
D. Brown	668/223	1138/305	1082/255	.299	.373	.424
H. Berger	146/200	320/309	246/288	.073	.103	.085
A. Davis	731/305	716/345	716/378	.239	.207	.189
G.R. Landis	694/332	787/356	767/238	.209	.221	.322
A. Saxe	331/186	197/291	436/228	.177	.067	.191
G. Saxe	27/59	184/172	240/137	.045	.106	.175

Compare Mean REM Density

LONG vs. SHORT

$\bar{X}$ = .194 $\bar{X}$ = .196

TABLE 10

MEAN OF NIGHTS 3-5

vs. NIGHT 5

		S(20-34)			S(35-49)		
		$\bar{X}$	N6	P	$\bar{X}$	N6	P
Sleep Latency		17.1±19.1	11.4±10.9	n.s.	27.1±37.8	20.6±27.8	n.s.
1st D-period	Latency	93.8±18.8	94.2±29.0	n.s.	70.4±17.2	97.6±48.4	.05/p/.10
Min. in 1st 3 Hours of Sleep	AW	5.0± 3.7	8.4±14.4	n.s.	10.4± 6.4	9.8± 8.4	n.s.
	D(REM)	24.7±20.9	29.2± 9.9	n.s.	30.8±11.5	28.5±14.2	n.s.
	1	4.5± 4.2	3.4± 4.0	n.s.	6.5± 5.2	8.3±10.2	n.s.
	2	82.1±14.7	75.4±18.0	n.s.	77.8±29.5	87.0±26.9	.05/p/.10
	3	18.0± 6.2	16.3± 7.6	n.s.	14.8± 6.1	13.5± 3.1	n.s.
	4	45.7±14.7	46.1±19.3	n.s.	39.7±31.7	34.0±25.9	n.s.
	Δ	63.7±16.6	62.6±21.6	n.s.	34.5±28.3	47.5±26.1	n.s.

TABLE 11

TOTAL SLEEP TIMES

Nights 3-5 and Night 5 vs. Night 6

	S (20-34)			S (35-49)		
	N5	N6	$\bar{X}$ (3-5)	N5	N6	$\bar{X}$ (3-5)
$\bar{X}$	330.8	377.5	330.1	333.2	316.4	312.9
Sx	26.5	63.4	28.6	21.4	61.0	12.8
P	.05/p/.10	.05/p/.10		n.s.	n.s.	

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13. ABSTRACT

Adult males who always sleep less than six hours or more than nine hours per day were studied. Over 400 were screened; smaller numbers had various psychological tests and psychiatric interviews, and finally 29, free of overt medical or psychiatric pathology, were studied in the laboratory for 8 nights each of 11-night polygraphic recording. Psychologically the short sleepers were efficient, hard-working, and somewhat hypomanic. The long sleepers tended to be anxious, depressed, or withdrawn. The two groups spent an almost identical amount of time -- 75 minutes -- in deep slow-wave sleep (stages 3-4), but the long sleepers had twice as much D-time (REM-time). It is suggested that there are two separate sleep requirements, a requirement for stage 3-4 sleep which is relatively constant across persons, and a requirement for D-time which is related to the personality and life-style of the individual.

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