



What is sleep and how do we measure it

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Who am I?

- Independent freelance sleep expert .
- Involved in sleep research for 37 years.
- Worked at
 - Neurosciences Division, R.A.F. Institute of Aviation Medicine
 - Human Psychopharmacology Research Unit, University of Surrey
 - Norfolk and Norwich University Hospital
 - London Clinic, Harley Street
 - ScanSleep, Copenhagen
 - Lovisenberg Hospital, Oslo
- Member of
 - European Sleep Research Society
 - American Academy of Sleep Medicine
 - British Sleep Society
- Published 38 peer-review papers

I'm safe at work so it doesn't matter if I'm sleepy?

False...being sleepy can cause:

- slower reaction time
- impaired judgements and decision making
- decline in attention
- decreased alertness
- increased moodiness and aggressive behaviour
- difficulty in remembering things

I can tell when I'm going to fall asleep

False....

- People do not know how sleepy they are
- The more tired you become, the less able you are to make a good judgement about your ability to remain awake

Drinking coffee cures sleepiness

False...

- Caffeine has a short term effect
- Caffeine should be used carefully as it will disrupt sleep
- Other measures such as opening windows and putting on the radio are not effective
- The only cure for sleepiness is to get some sleep

All the best people needed less sleep

False

- No evidence that Leonardo Da Vinci, Michelangelo, Thomas Edison or Margret Thatcher needed less sleep
- Ghengis Khan, Napoleon and Hitler were all famous short sleepers
- Einstein needed 11 hours a night

Why We Aren't Sleeping...

- Volitional sleep deprivation (work, lifestyle)
- Poor sleep habits
- Circadian factors (shift work)
- Environmental disruptions
- Untreated sleep problems/disorders
- **We don't take sleep seriously!!!**

Sleep and Business

- A survey of more than 180 business leaders found that four out of 10 (43%) say they do not get enough sleep at least four nights a week.
- Such sleep deficiencies can undermine important forms of business behaviour and eventually hurt financial performance.

Link Between Effective business performance and Getting Enough Sleep

- Four types of leadership behaviour are most commonly associated with high-quality executive teams:
 - operating with a strong orientation to results
 - solving problems effectively
 - seeking out different perspectives
 - supporting others.
- In all four cases is the proven link between sleep and effective business performance.

The prefrontal cortex

- The prefrontal cortex directs all the higher-order cognitive processes, such as
 - Problem solving
 - Reasoning
 - Organizing
 - Inhibition
 - Planning
 - Executing plans.
- all behaviour relies on at least one (and often more than one) of these executive functions

The prefrontal cortex and sleep

- Tasks that require planning, strategy, or a complex sequence of steps to complete are more difficult when one is sleepy. This general category of tasks (requiring motivation linked to abstract goals, delayed rewards/consequences, planning, strategy, and so on) involves abstract processing areas in the front of the brain (regions of the prefrontal cortex) that appear to be particularly sensitive to sleep deprivation.

German bank supervisor unfairly fired over 'sleep error'

- A German labour court has ruled that a bank supervisor was unfairly sacked for missing a multi-million-euro error by a colleague who fell asleep during a financial transaction.
- The clerk was transferring 64.20 Euros (£54.60) when he dozed off with his finger on the keyboard, resulting in a transfer of 222,222,222.22 Euros.
- His supervisor was fired for allegedly failing to check the transaction.

What is sleep?





*“...for Sleepe is that golden
chaine that ties health and our
bodies together”.*

●●● Thomas Dekker English dramatist (1609)

The importance of sleep



“ If sleep does not serve an absolutely vital function,
then it is the biggest mistake
the evolutionary process ever made¹ ”

1. Rechtschaffen. The control of sleep. In: Hunt, editor. Human behaviour and its control. Cambridge, MA: Schenkman; 1971

How we fall asleep

- 1. Sun sets
- 2. Decline in the blue end of light spectrum
- 3. SCN (our biological clock) signals the Pineal gland to produce more melatonin
- 4. Melatonin level rises
- 5. We start feeling sleepy
- 6. We fall asleep.

Function of sleep

- Sleep remains a biological enigma
- Sleep is not negotiable- it is a biological imperative
- Needed for recuperation and restoration of physical and mental functioning.
- Sleep is important for optimal functioning of the endocrine, metabolic and immune system.
- Sleep affects all organs of the body.
- But primarily sleep is of the brain and for the brain.

Different States of Sleep

●●● Non-REM (NREM) sleep (75-80%)

Increasing sleep depth & decreasing muscle tone, decreasing respiratory & heart rate & decreasing eye movement, physical rest & immune system. Memory and physiological rest.

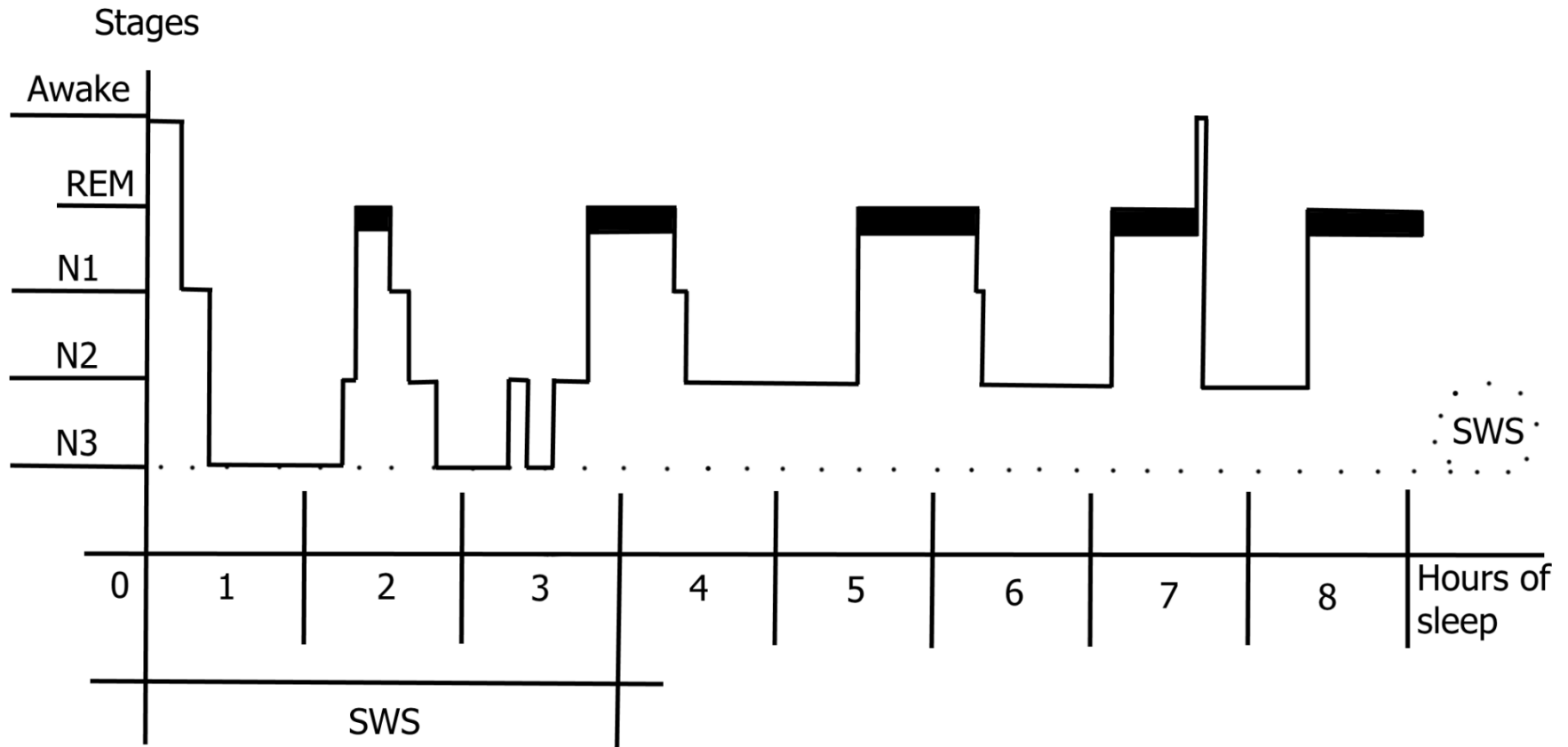
- Stage N1: transition from awake to sleep (1-5%)
- Stage N2: true sleep (45-50%)
- Stage N3: deep, slow wave sleep (SWS: 25-27%)

●●● Rapid Eye Movement (REM) sleep (20-25%)

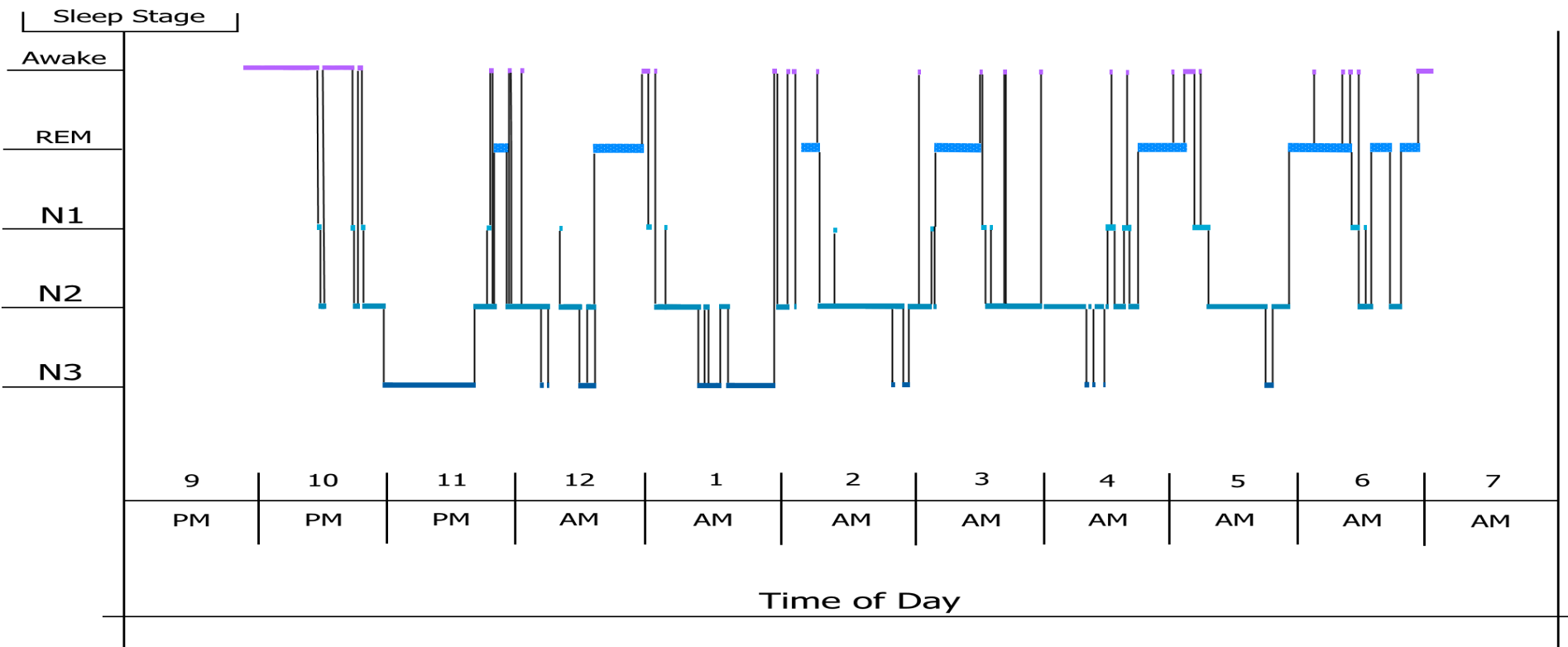
Irregular breathing and increased heart rate, very low muscle tone, vivid dreams

Psychological rest, emotional well-being & memory

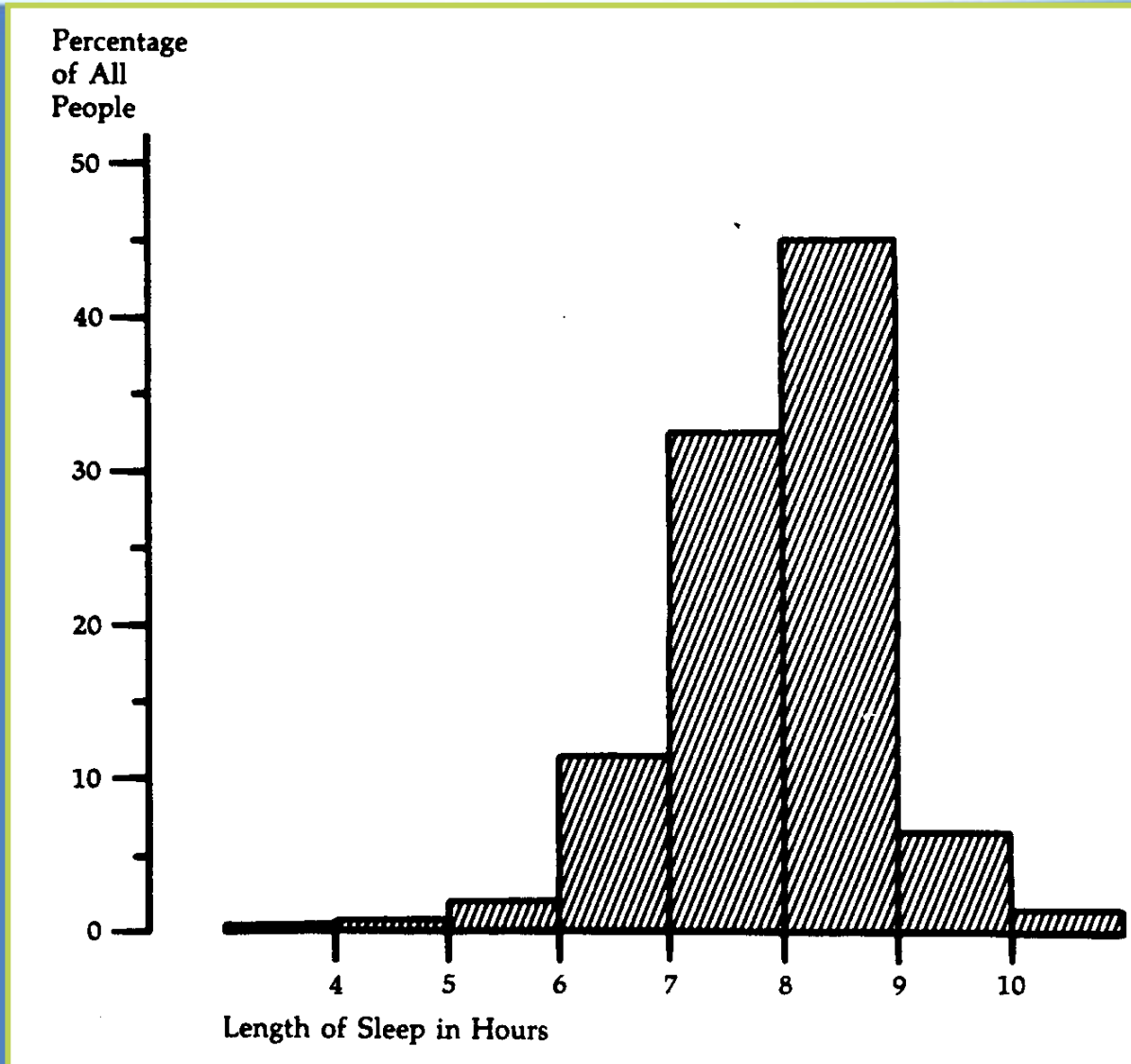
'Normal' Sleep Hypnogram



Real Sleep Hypnogram



Total Sleep Requirement



The Acute Effects of Sleepiness

- Involuntary “micro sleeps” occur
- Reaction times slower
- Attention becomes unstable
 - vigilance poor, lapses increase
 - short term memory suffers
 - unable to sustain performance
- Problem solving and judgement deteriorate
 - frontal lobe function particularly affected
 - inflexible behaviour (note industrial accidents)
 - sense of humour, moral judgement, risk taking

Signs of sleepiness

The signs include:

- not feeling refreshed after sleep
- difficulty keeping your eyes open and focussed
- greater tendency to fall asleep while at work
- more frequent naps during leisure hours
- extended sleep during days off
- increased errors and loss of concentration at work
- feeling irritable, restless and impatient

How sleepy are you?



Epworth Sleepiness Scale

- Use the following scale to choose the most appropriate number for each situation.
 - 0 = would never doze
 - 1 = slight chance of dozing
 - 2 = moderate chance of dozing
 - 3 = high chance of dozing

Epworth Sleepiness Scale

Sitting and reading?



Epworth Sleepiness Scale

Watching TV?



Epworth Sleepiness Scale

Sitting inactive in a public place (e.g., a theater or a meeting)?



Epworth Sleepiness Scale

As a passenger in a car for an hour without a break?



Epworth Sleepiness Scale

Sitting and talking to someone?



Epworth Sleepiness Scale

Sitting quietly after a lunch without alcohol?



Epworth Sleepiness Scale

In a car, while stopped for a few minutes in traffic?



Epworth Sleepiness Scale

Lying down to rest in the afternoon when
Circumstances permit?



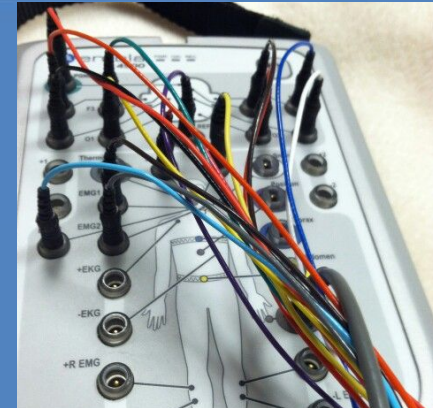
Epworth Sleepiness Scale

- A score of ≤ 10 is considered normal
- A score of > 10 suggests excessive sleepiness

Objective measurement of sleep

Polysomnography (PSG)

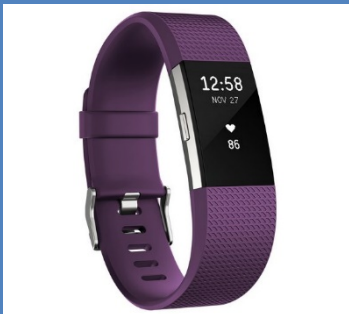
- sleep structure / sleep stages
- diagnosis of sleep apnoea and parasomnias



Actigraphy

- circadian rhythm
- rest activity pattern

Commercial devices for tracking activity and sleep



Polysomnography



Sleep Architecture

- The NREM/REM stage and cycle infrastructure of sleep understood from the vantage point of the quantitative relationship of these components to each other.

Time in bed

- Time in bed is the total number of minutes that a patient spends in bed. This amount varies for different age groups and can also vary on an individual patient basis. This is important because it gives a basic idea as to whether or not the patient is spending enough time attempting to sleep.

Total Sleep Time

- Total sleep time is the actual amount of sleep time in a sleep period ; equal to total sleep period less movement and awake time. Total sleep time is the total of all REMS and NREMS in a sleep period. This is important because it gives a basic idea as to whether or not the patient is achieving enough sleep for the time they are in bed.

Sleep Efficiency

- Sleep efficiency is the proportion of sleep in the period potentially filled by sleep, that is, the ratio of total sleep time to time in bed. This is important because it displays the patients overall quality of sleep as it pertains to any sleep disorder they exhibit.

Sleep Latency

- Sleep latency is the period of time measured from “lights out”, or bedtime, to the commencement of sleep. This is important because it can show the level of sleepiness by how fast the patient gets to sleep or their sleep latency. It can also help to determine insomnia in patients that displays signs of excessive daytime sleepiness but do not achieve sleep in a timely manner.

Wake Percentage

- Wake percentage is the percentage of wake scored from lights out to the final wake-up. This is important because it will help determine how much any sleep disorder is affecting the patient's sleep architecture.

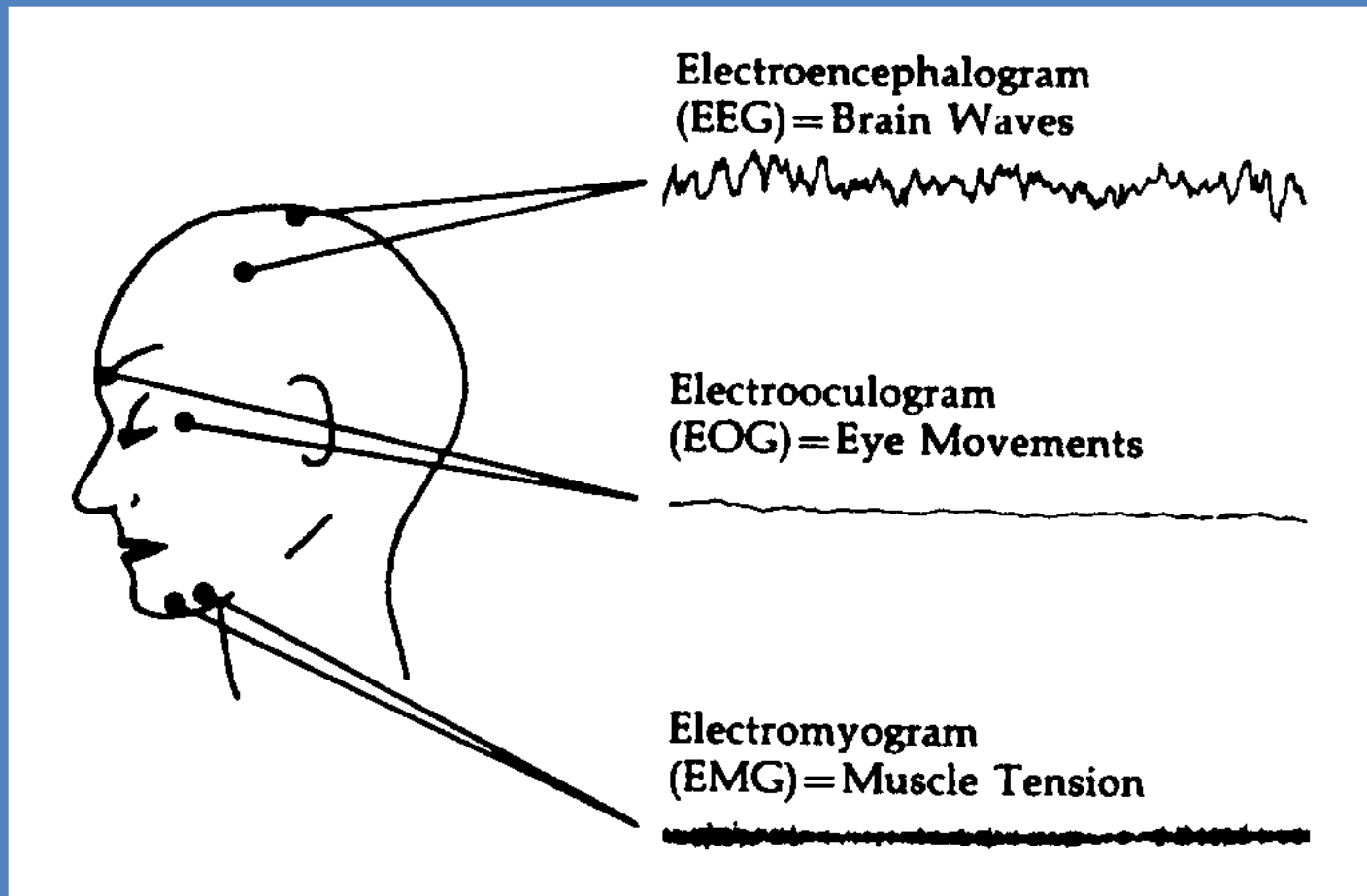
REM latency

- REM latency is the period of time from sleep onset to the first appearance of REM sleep. This is important in showing a short onset of REM sleep, which is a sign of Narcolepsy.

Parameters for Staging Human Sleep

- Electrooculogram (EOG) leads - left eye and right eye
- Electroencephalogram (EEG) leads - one central EEG lead and one occipital EEG lead (minimum)
- Electromyogram (EMG) lead - one submental EMG channel

Polygraphic Monitoring



States of Being EEG

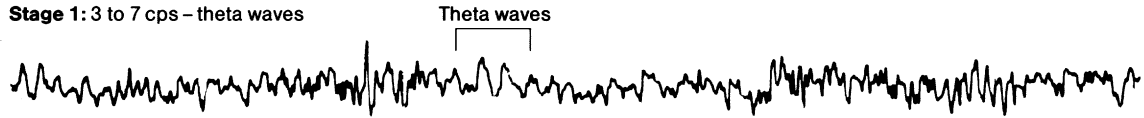
Awake: low voltage – random, fast



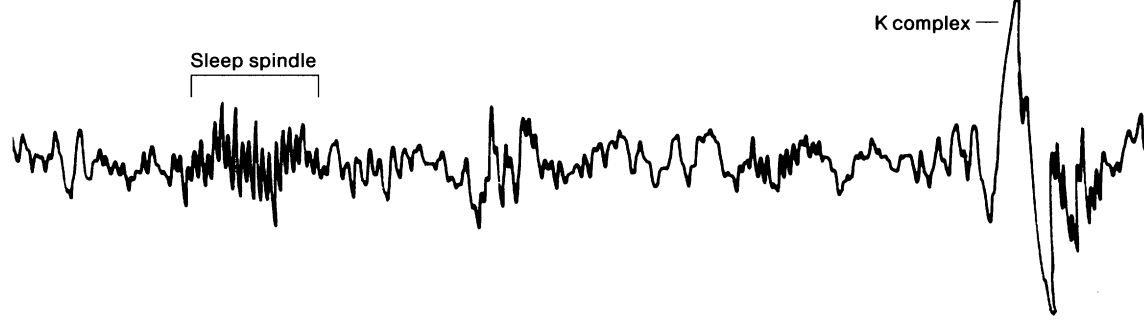
Drowsy: 8 to 12 cps – alpha waves



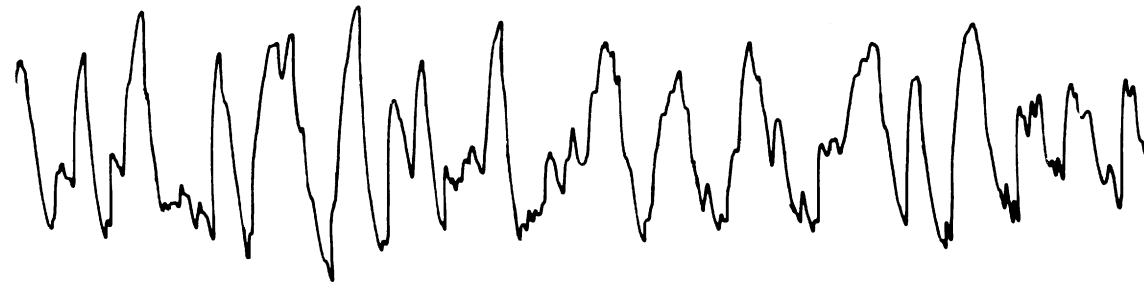
Stage 1: 3 to 7 cps – theta waves



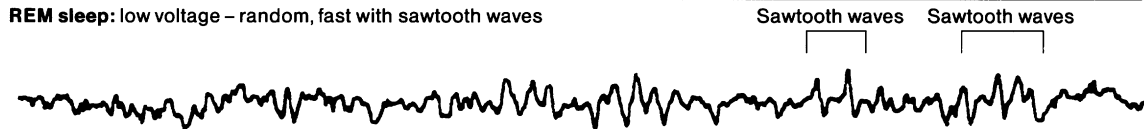
Stage 2: 12 to 14 cps – sleep spindles and K complexes



Delta sleep: (stages 3 and 4) $1\frac{1}{2}$ to 2 cps – delta waves $>75 \mu$ V

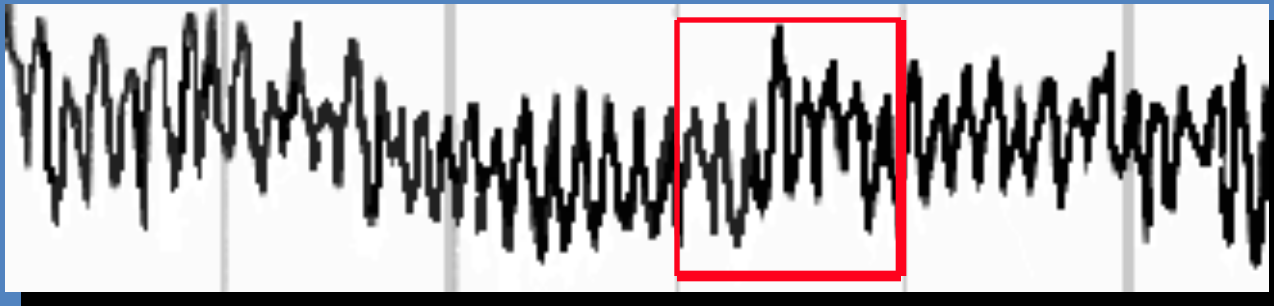


REM sleep: low voltage – random, fast with sawtooth waves



Alpha Activity

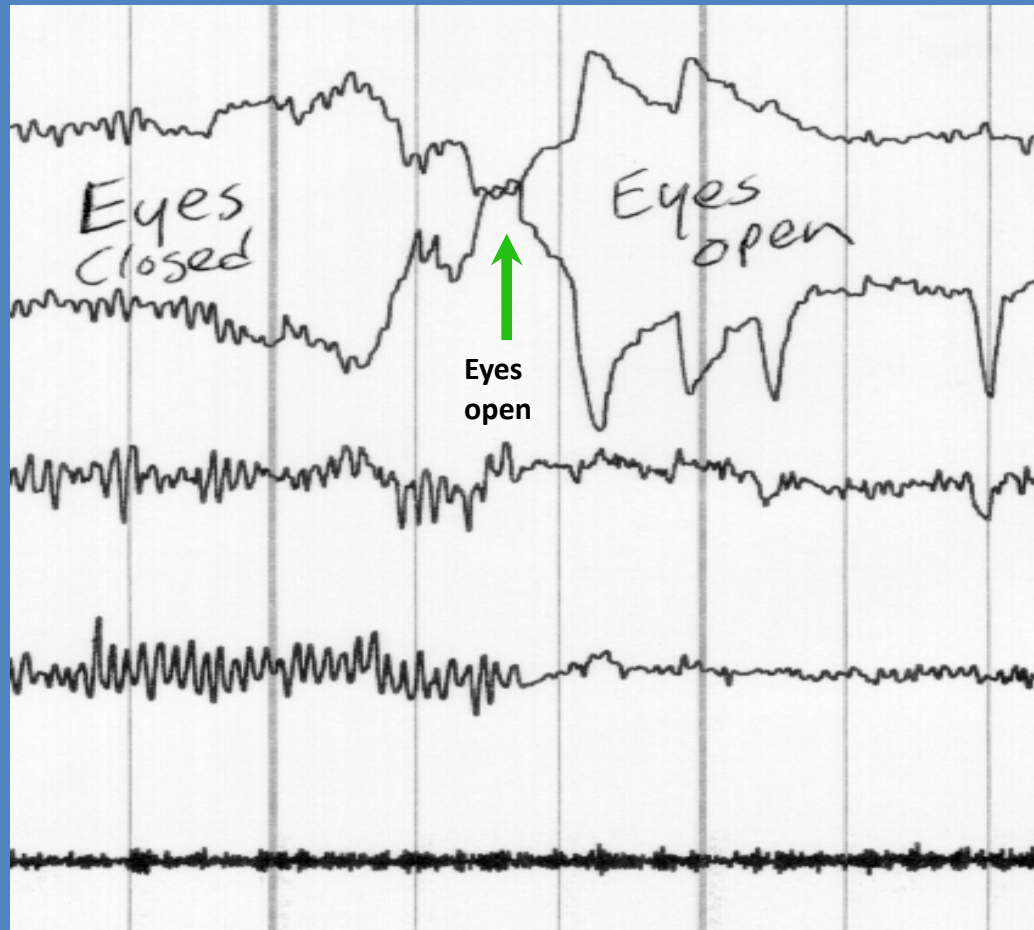
- Alpha EEG: 8-13 cps
- Alpha: occipital region
- Alpha: crescendo-decrescendo appearance



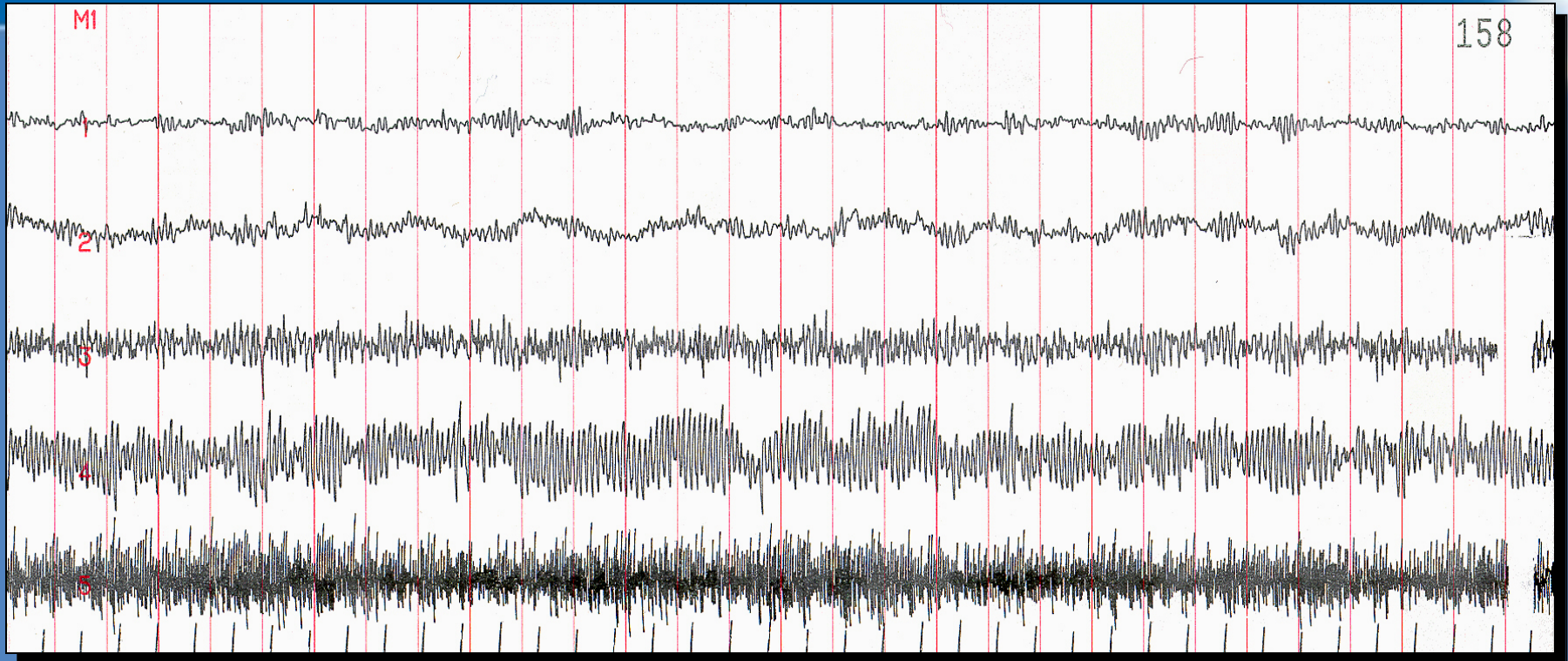
Central lead EEG tracing (zoomed to 4 times larger than normal)

Stage Wake

Eyes Closed vs. Eyes Open



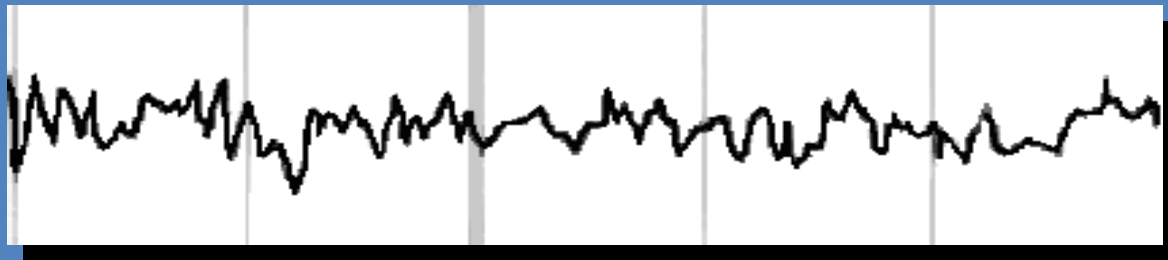
Stage Wake



- >50% of each epoch contains Alpha activity.
- Slow rolling eye movements or eye blinks will be seen in the EOG channels
- Relatively high submental EMG muscle tone

Theta Activity

- A frequency of 3-7 cps
- Produced in the central vertex region
- No amplitude criteria for Theta
- The most common sleep frequency



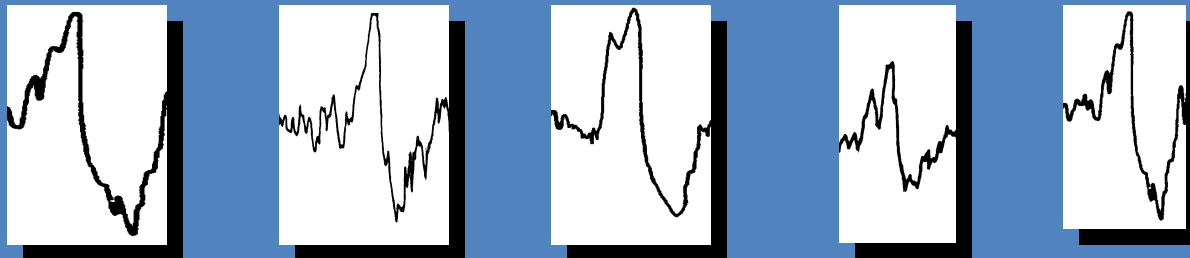
Stage One Sleep



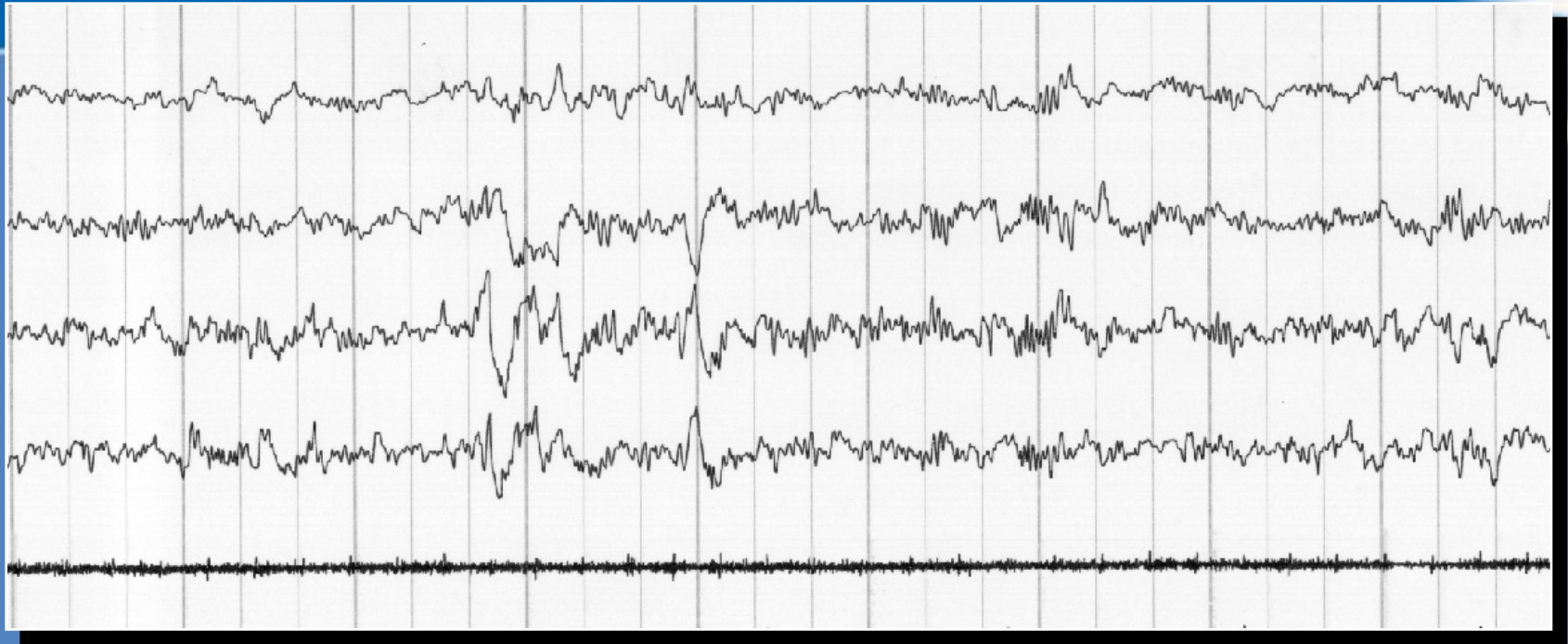
- $\geq 50\%$ of the epoch contains Theta activity (3-7 cps) There may be Alpha activity within $<50\%$ of the epoch.
- Slow rolling eye movements in the EOG channels
- Relatively high submental EMG tone

K Complexes

- Sharp, slow waves, with a negative, then positive deflection
- No amplitude criteria
- Duration must be at least .5 seconds
- Predominantly central-vertex in origin
- Indicative of stage 2 sleep
- They may occur with stimuli or without stimuli



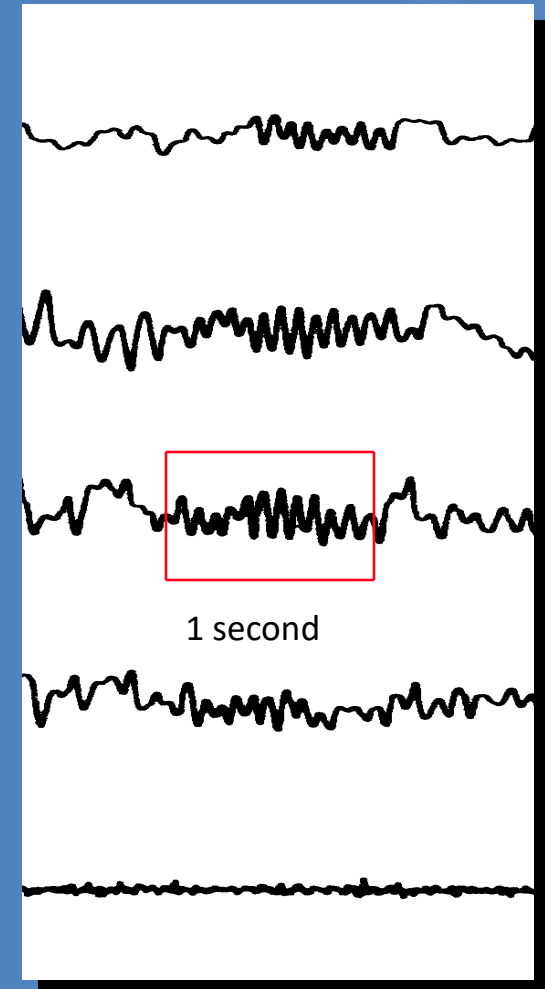
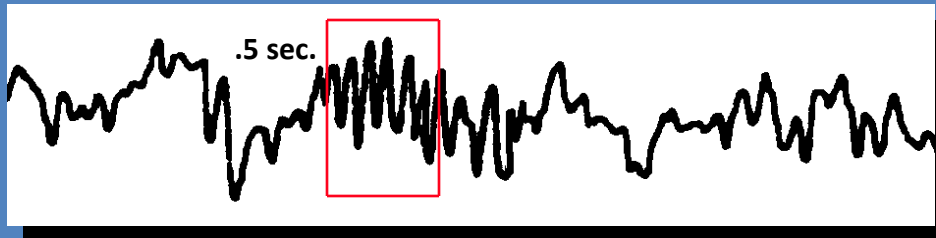
Stage Two Sleep



- Background EEG is Theta (3-7 cps.)
- K-Complexes and spindles occur episodically
- Mirrored EEG in the EOG leads
- Low tonic submental EMG

Sleep Spindles

- Sleep Spindle - 12-14 cps
- Central - vertex region
- $\geq .5$ to 2-3 seconds in duration
- .5 second spindles - 6-7 cycles
- Indicative of stage 2 sleep

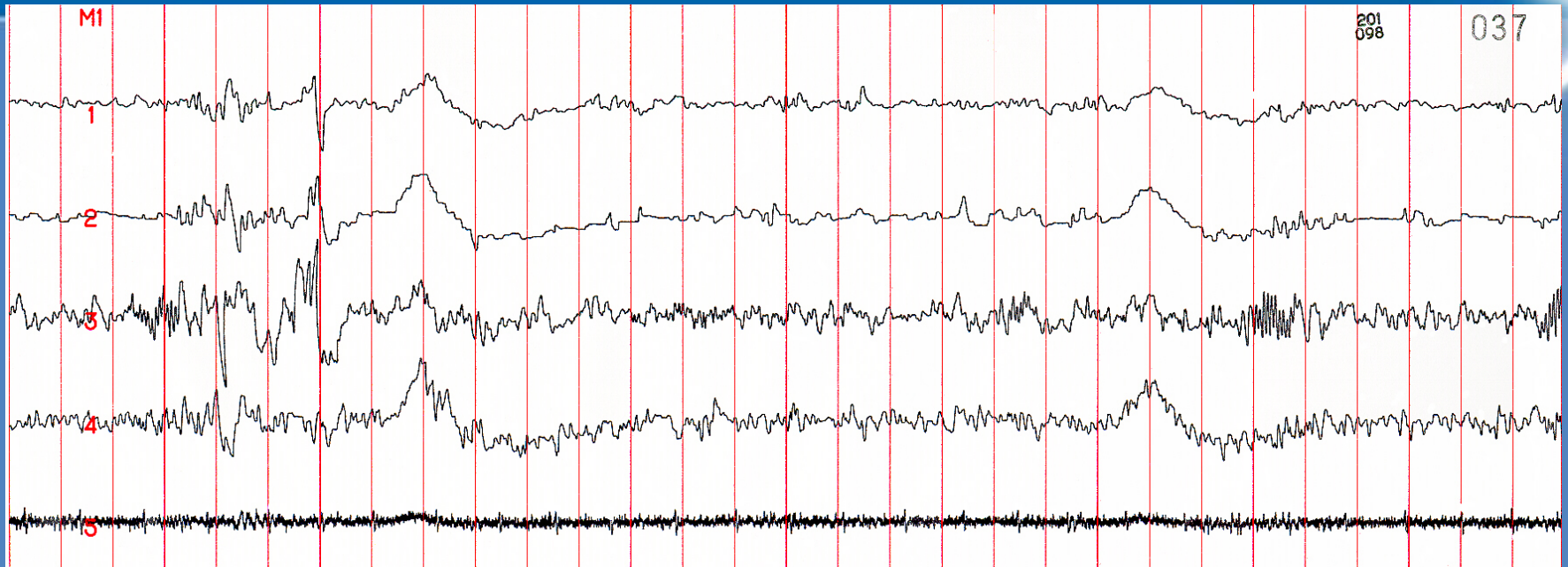


Stage N2 Sleep



- Excessive spindles may indicate the presence of some medications (benzodiazepines)
- Normal variant for scoring human sleep

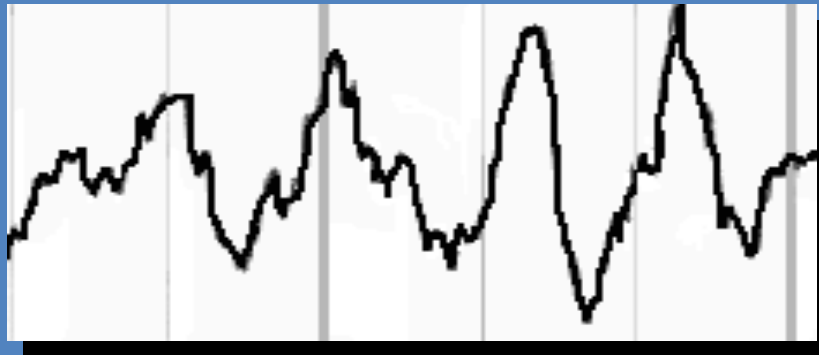
Stage N2 (Typical look)



- Stage 2 sleep with low K complex quantity and high amplitude spindles
- Normal variant

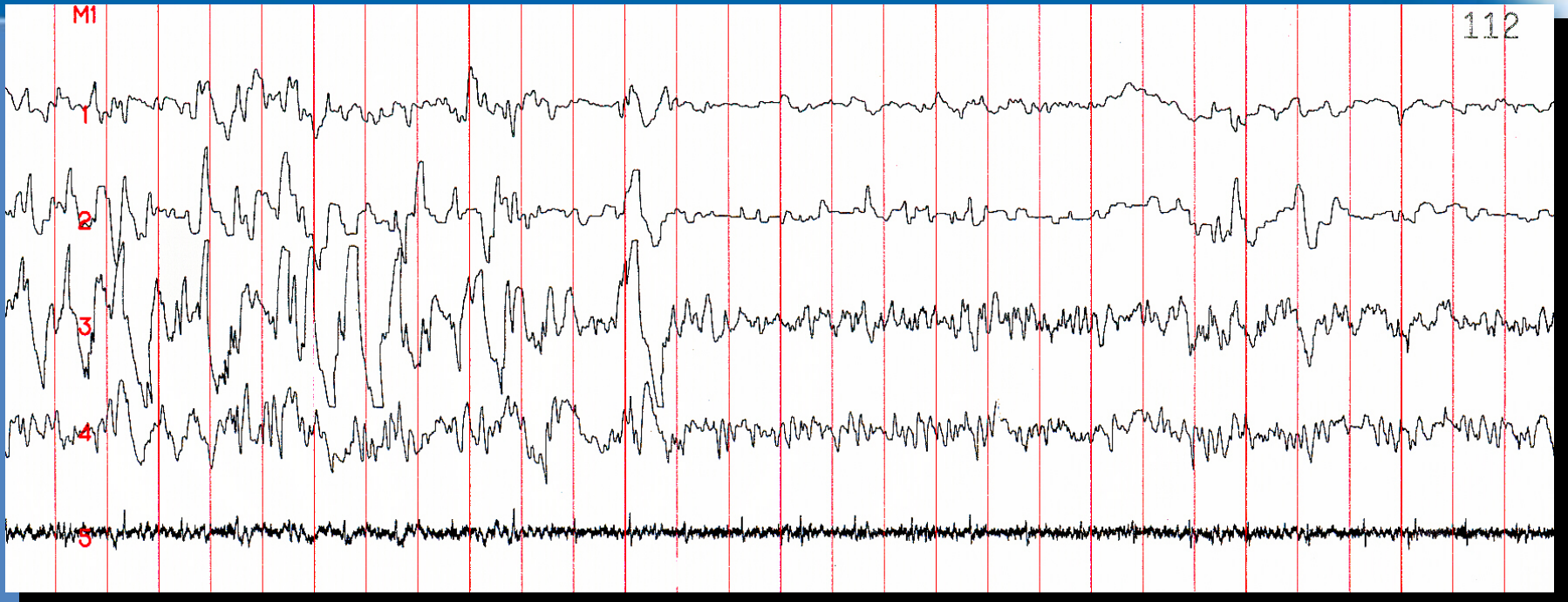
Delta Activity

- Sleep Delta activity - frequency of .5-2 cps
- Clinical EEG - frequency of $\geq .5$ -4 cps
- Seen predominantly in the frontal region
- Delta Activity - amplitude of ≥ 75 mn



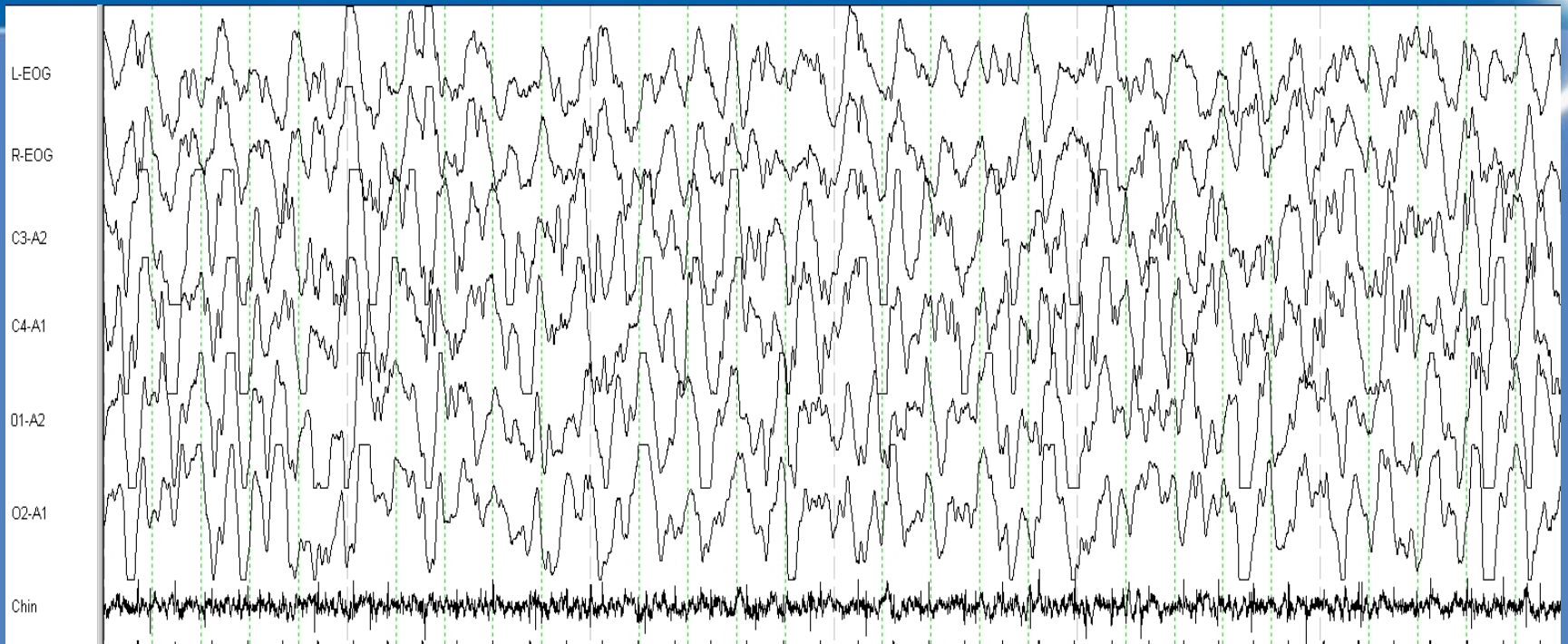
Delta EEG Activity (zoomed in 4 times larger than normal)

Stage N3 Sleep (early)



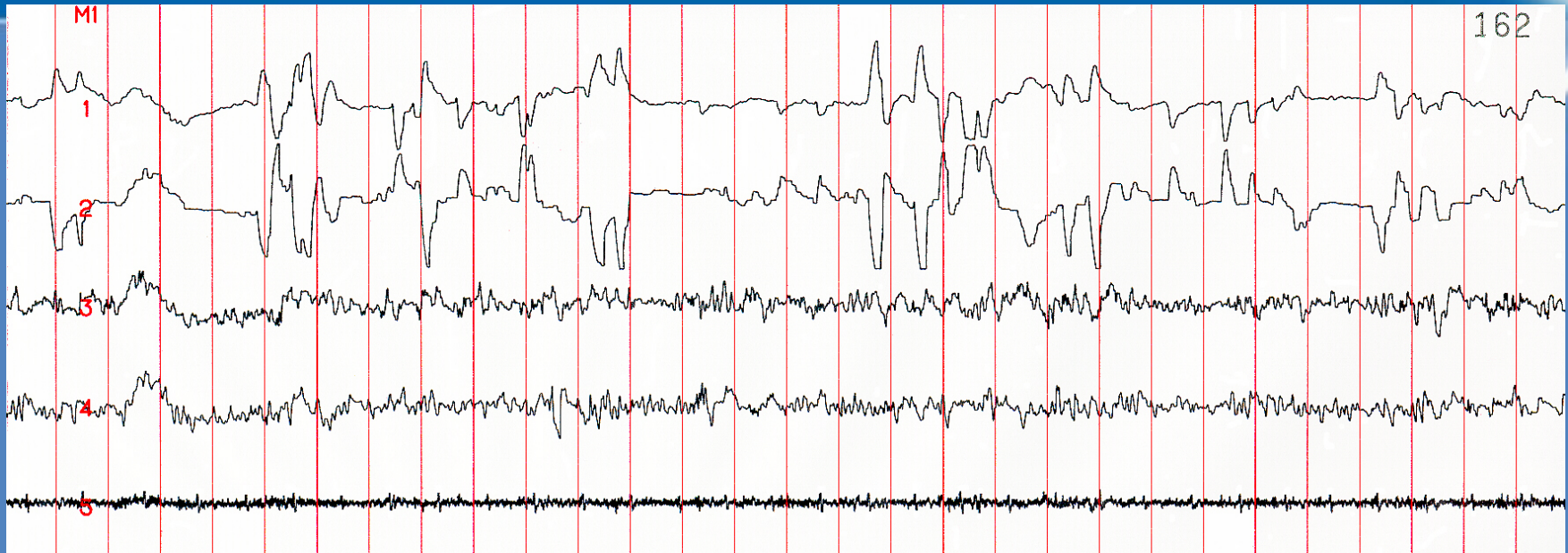
- EOG leads will only pick up the EEG activity
- EMG may be slightly lower than that of Stage two

Stage N3 Sleep



- EOG is only recording frontal EEG activity

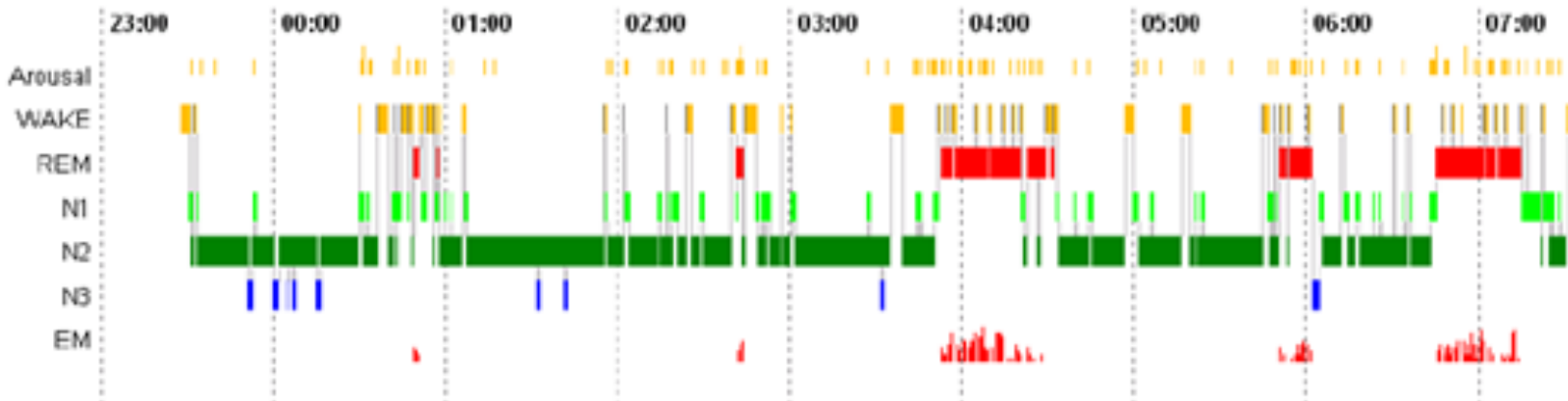
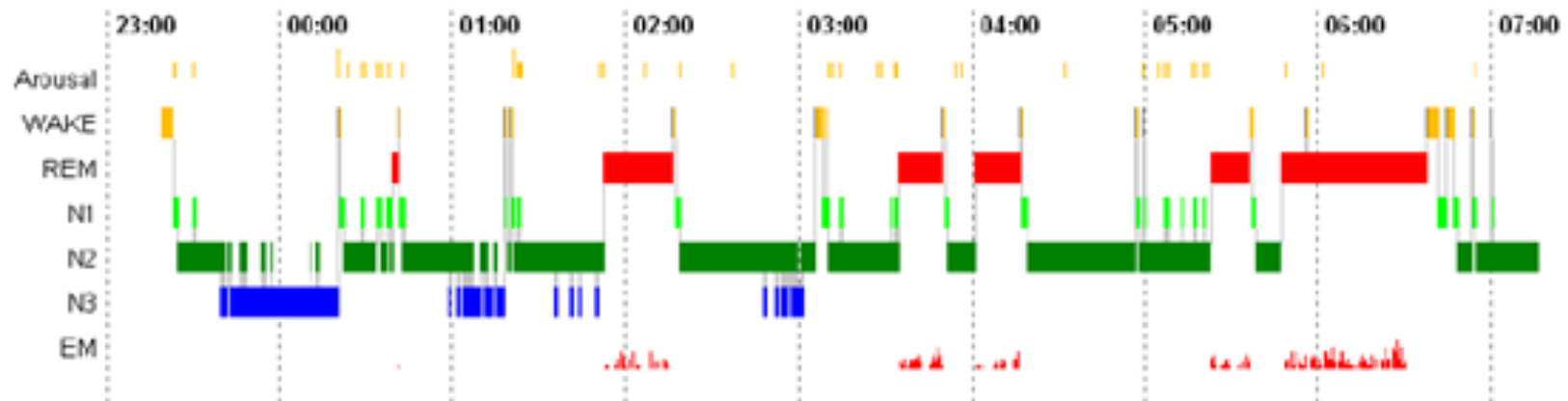
Stage REM Sleep



- Mixed frequency EEG. Alpha may be seen; usually 1-2 cps slower than waking
- REM's are seen in the EOG leads
- Low submental EMG
- Any two of the previous three criteria must be present to score REM sleep

“I haven’t slept a wink all night!”

**Polysomnographic profile of a good sleeper (upper panel)
and a patient with insomnia (lower panel)**



Data from Freiburg sleep lab



Sleep Study Sample Report

Sleep Summary– Whole Night

Time at Lights Off	21:50:57	Sleep Onset Latency (SL)	27.8 min.
Time at Lights On	05:50:42	Number of Stage N1 Shifts	36
Total Recording Time (TRT)	479.8 min.	Number of Stage Shifts	206
Sleep Period Time (SPT)	452.0 min.	Number of Awakenings	17
Total Sleep Time (TST)	413.5 min.		
Sleep Efficiency (SE)	86.2%	REM Latency	141.0 min.

Sleep Stage Summary– Whole Night

Stage	Duration (min)	% TST	% SPT	Latency (min)
WASO	38.5	-	8.5	-
Stage N1	30.0	7.3	6.6	0.0
Stage N2	242.0	58.5	53.5	2.0
Stage N3	64.5	15.6	14.3	22.5
Stage REM	77.0	18.6	17.0	141.0

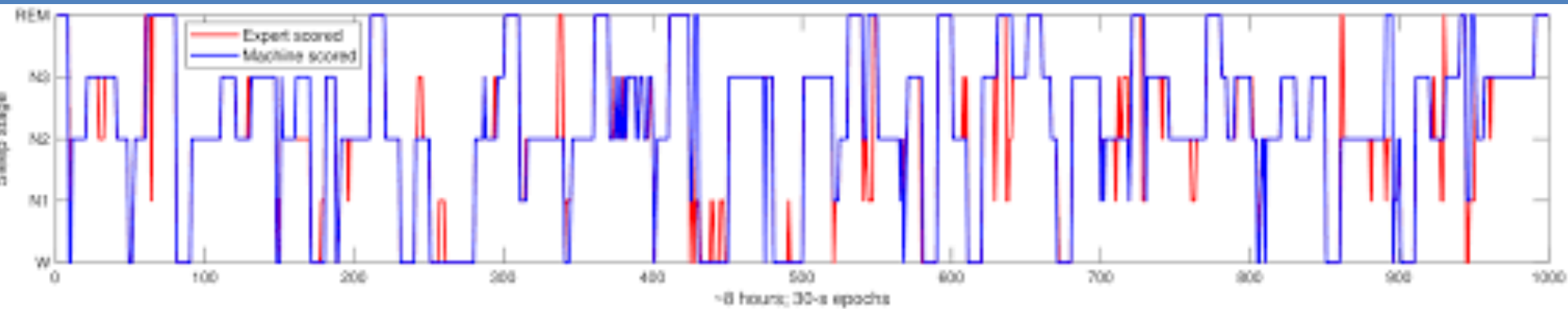
Sleep Continuity– Whole Night

Source of Arousals	NREM Count	NREM Index	REM Count	REM Index	Total Count	Total Index
Spontaneous	0	0.0	0	0.0	0	0.0
Apneas / Hypopneas	72	12.8	31	24.2	103	14.9
RERAs	45	8.0	7	5.5	52	7.5
Snoring	0	0.0	0	0.0	0	0.0
PLM / Limb Mvmnts	0	0.0	0	0.0	0	0.0
Total Arousals	117	20.9	38	29.6	155	22.5

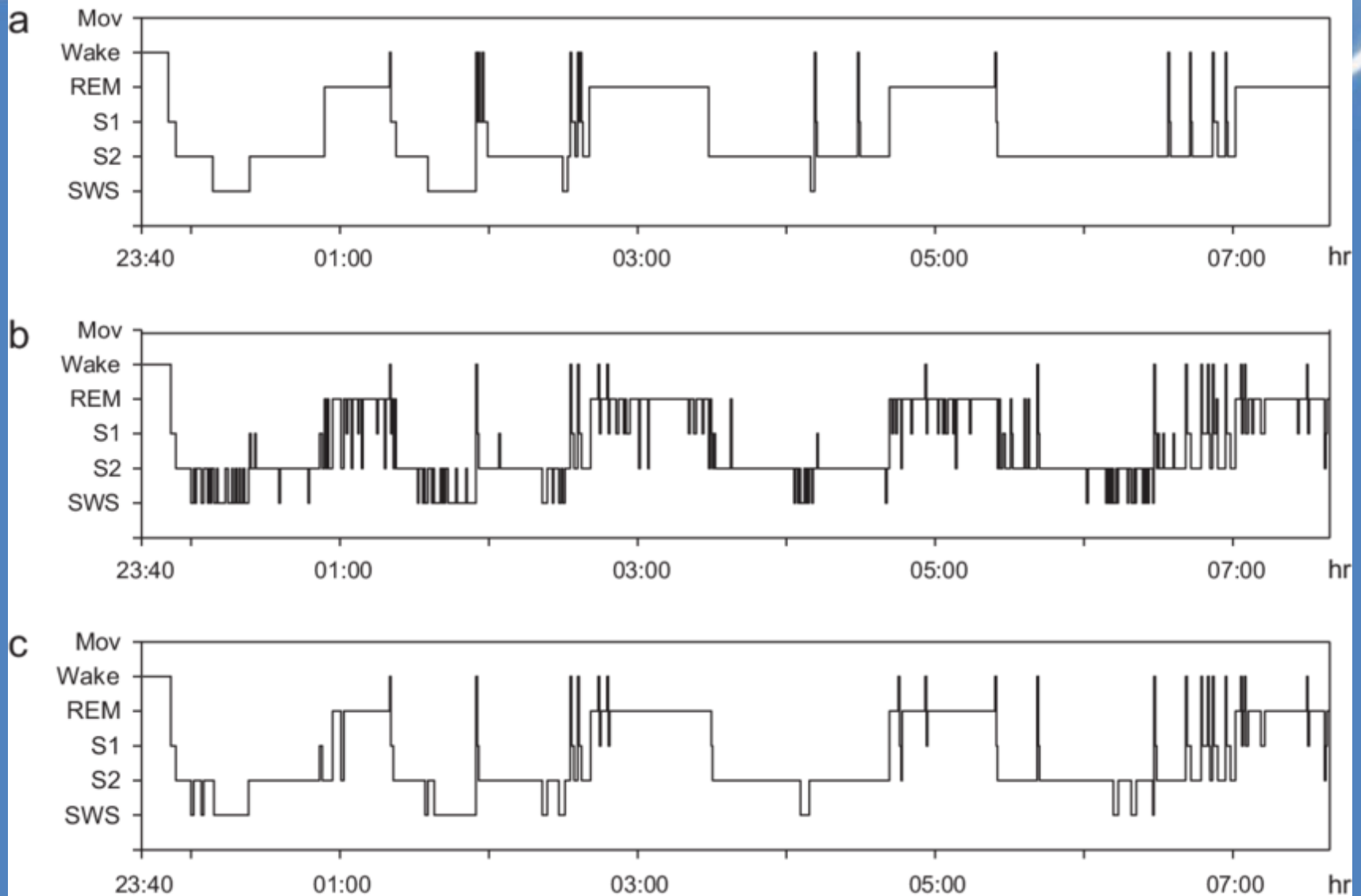
Major issues in sleep analysis

- Our understanding of sleep and its neural mechanism is grossly inadequate.
- Modern sleep classification is based on the age old belief that sleep consists of REM sleep and Non-REM sleep.
- Classification of sleep into REM and Non-REM started with the assumption that REM sleep is sleep with dream, and Non-REM is dreamless sleep.
- Use of computer has helped in fast analysis of large data.
- But there are major differences between manual (visual) scoring, and computer scoring.

Automatic Sleep Scoring



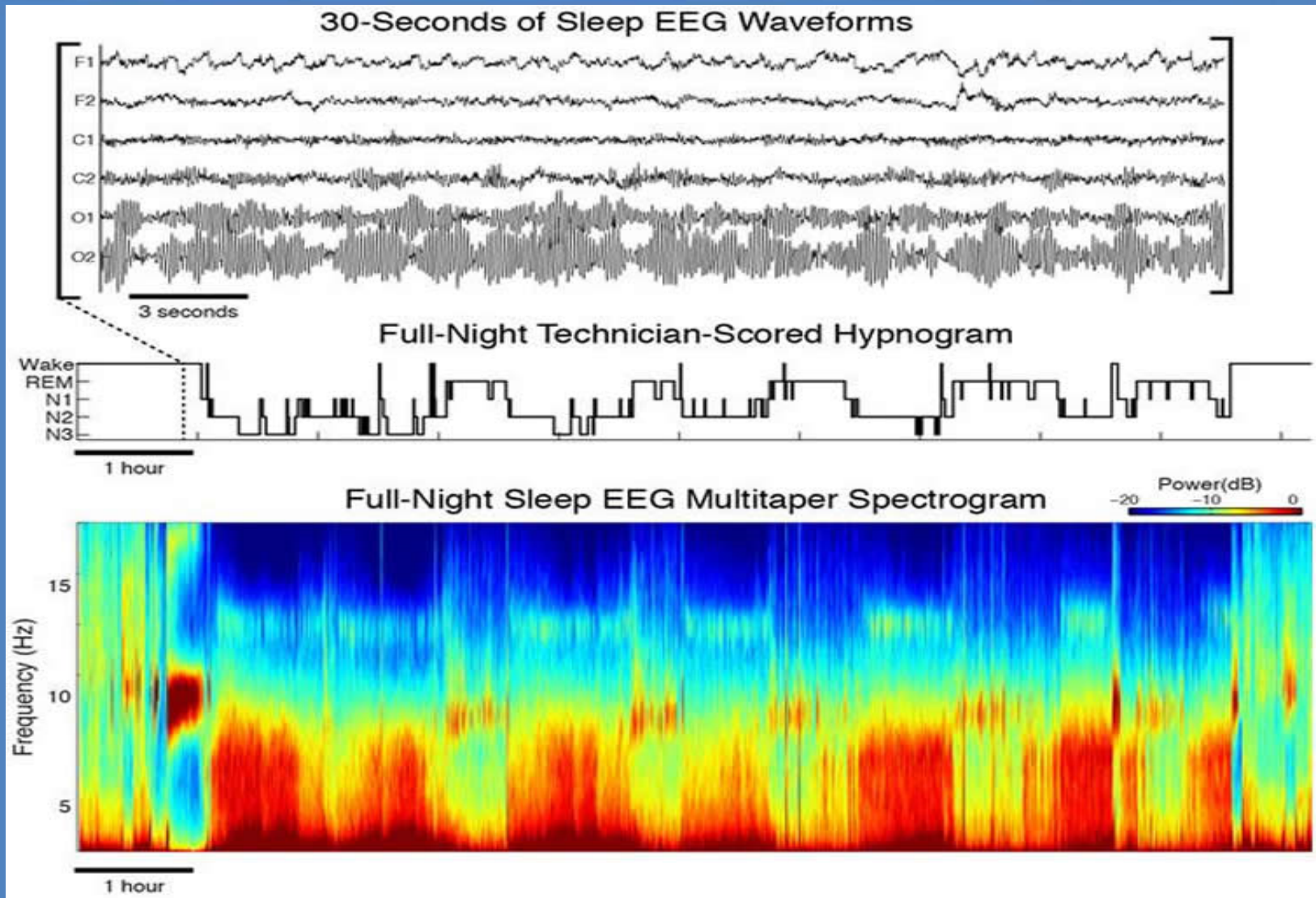
Automatic Sleep Scoring



Principal Component Analysis of EEG

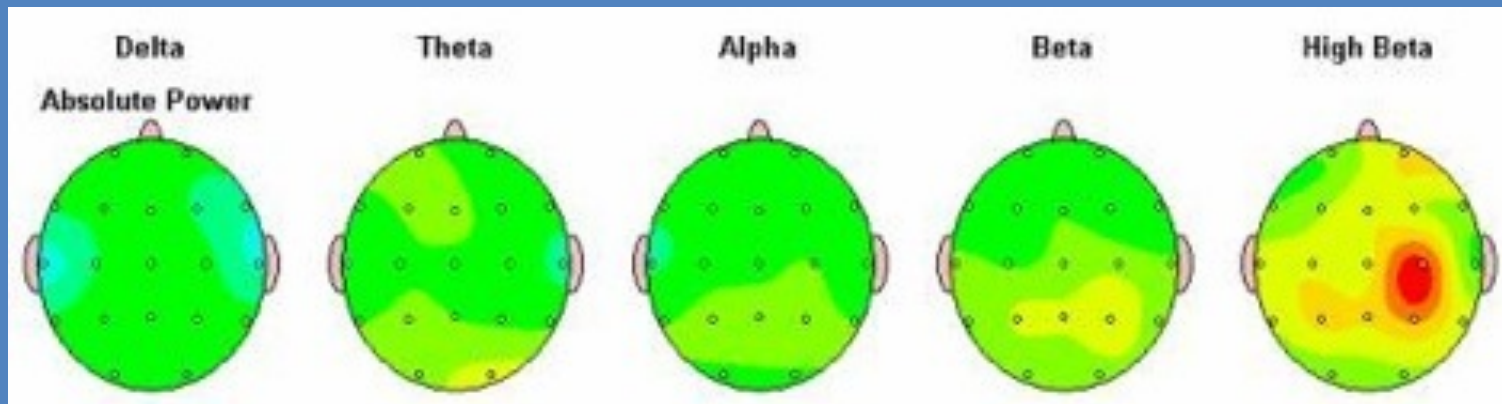
- EEG after Fourier Transformation can be subjected to Principal Component Analysis
- Principal components of different sleep-wakeful states are:
 - NREM: 1-8 Hz & 5-15 Hz
 - REM: 1-9 Hz & 10-15 Hz
 - Wakefulness: 1-7 Hz, 7-11 Hz, & 12-15 Hz
- Alpha band was identified only during wakefulness.
(Corsi-Cabrera et al, 2000)

Spectral analysis



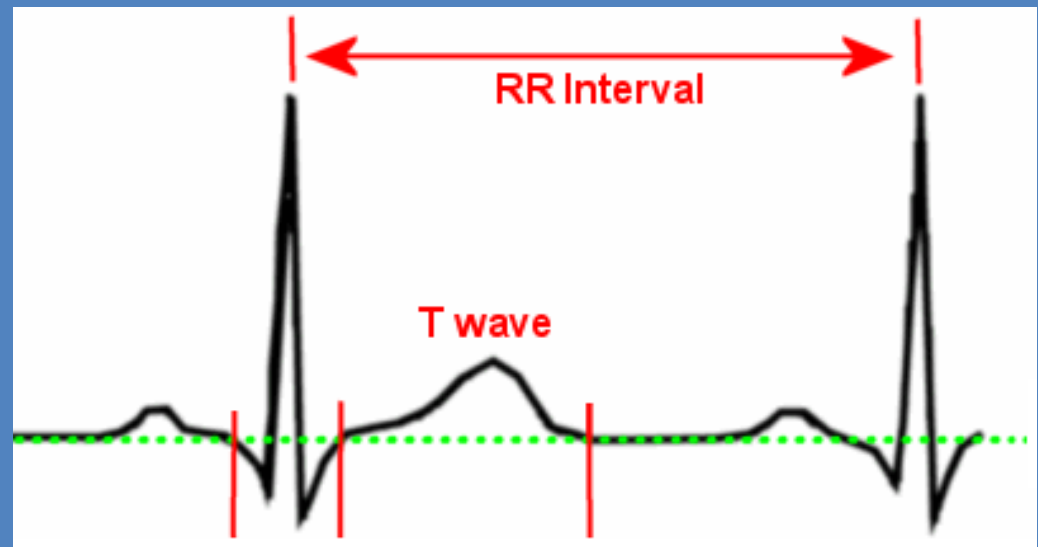
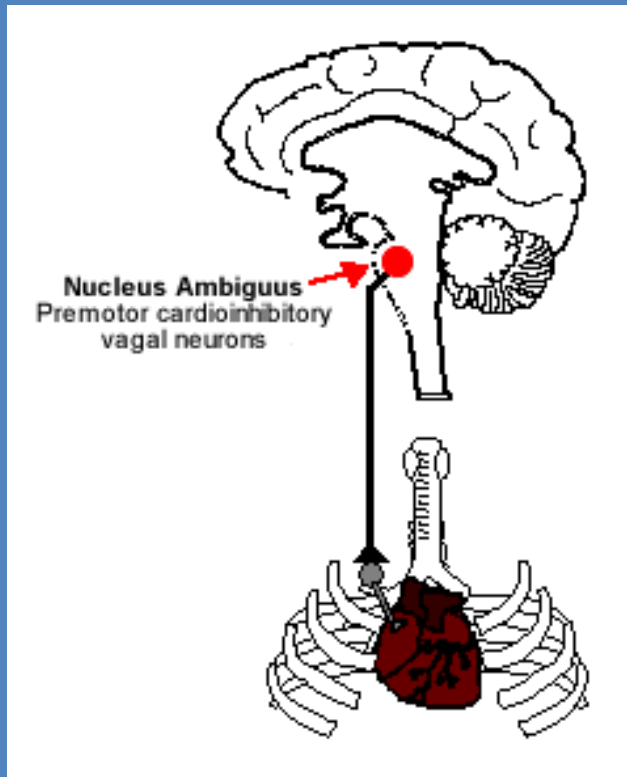
Localization of dominant band in the EEG

- Power spectral analysis can also be used to show the area of dominance of each band in the EEG

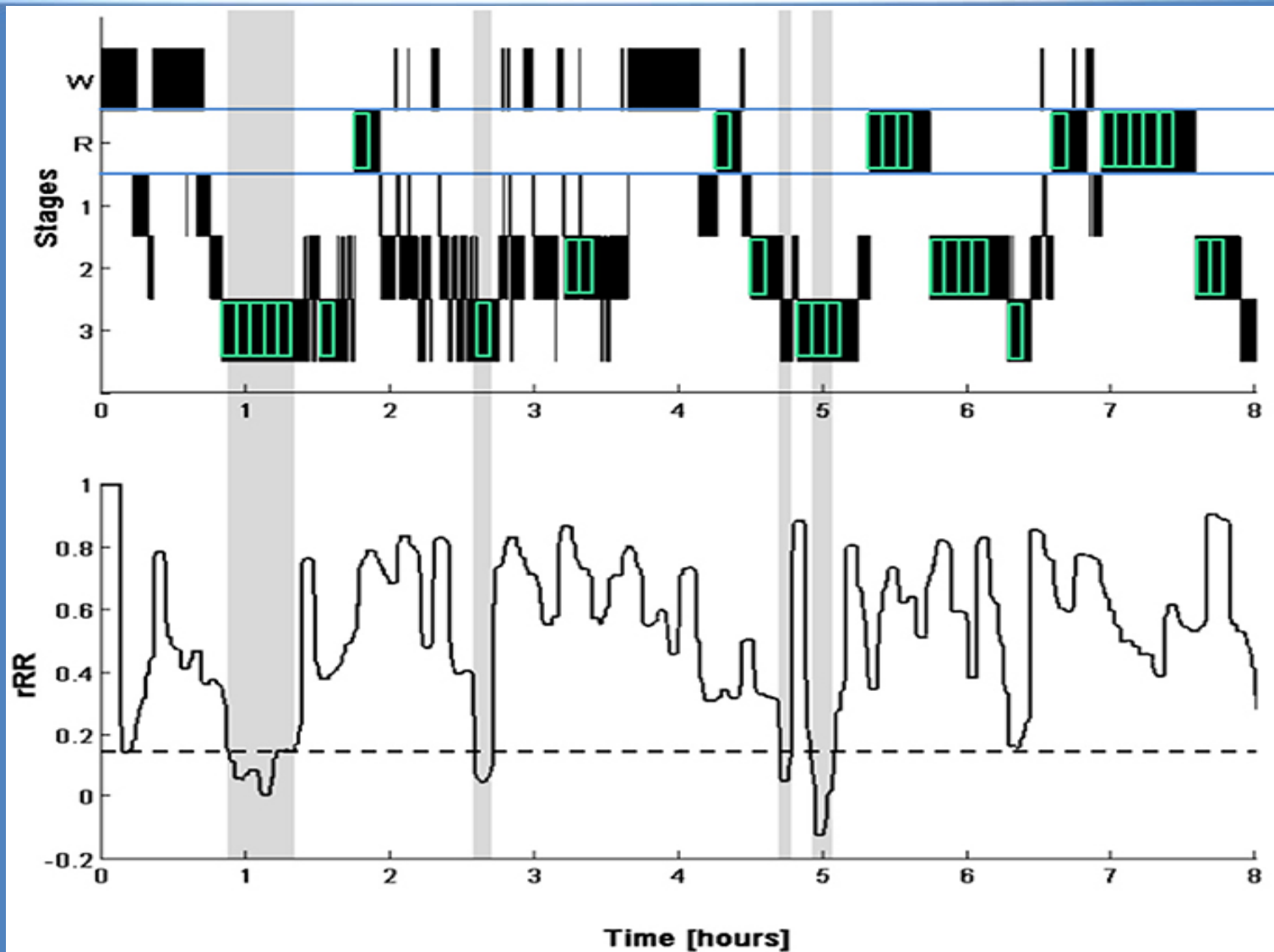


Heart-rate variability

- Normal ECG exhibits periodic variation in R-R intervals, called Heart rate variability (HRV).



Heart Rate Variability and Sleep



Sleep assessment: future

- Present polysomnographic assessment is helpful in clinical situations and in healthy subjects.
- But we are still far from adequate assessment of sleep.
- Electrophysiologically and behaviorally defined sleep do not explain all the aspects of sleep.

Actigraphy

Worn on non-dominant hand

Cheaper and less cumbersome than PSG

Likely higher compliance



ACTIGRAPHY

- Actigraphy utilizes a portable device (the actigraph) usually worn on the wrist that records movement over an extended period of time .
- Sleep-wake patterns are estimated from the pattern of movement.
- Software is available to estimate TST and wake time from the data.
- The sleep/wake pattern of actigraph data is extremely valuable in documenting patterns of sleep and wake.
- Studies of actigraphy have usually compared the results with that of PSG or sleep logs. However, actigraphy does not measure sleep (EEG) or the subjective experience of sleep (sleep logs).

Actigraphy in Insomnia

- Sleep logs and actigraphy provides complementary information.
- Both actigraphy and sleep logs underestimated TST and overestimated wake time.
- Actigraphy underestimated the sleep latency whereas sleep logs overestimated the sleep latency.
- Actigraphy was found to be more sensitive at detecting treatment effects than sleep logs. In contrast, different results was found in a group of older adults treated for primary insomnia (expected to have more wake time). Actigraphy slightly overestimated TST and underestimated wake.

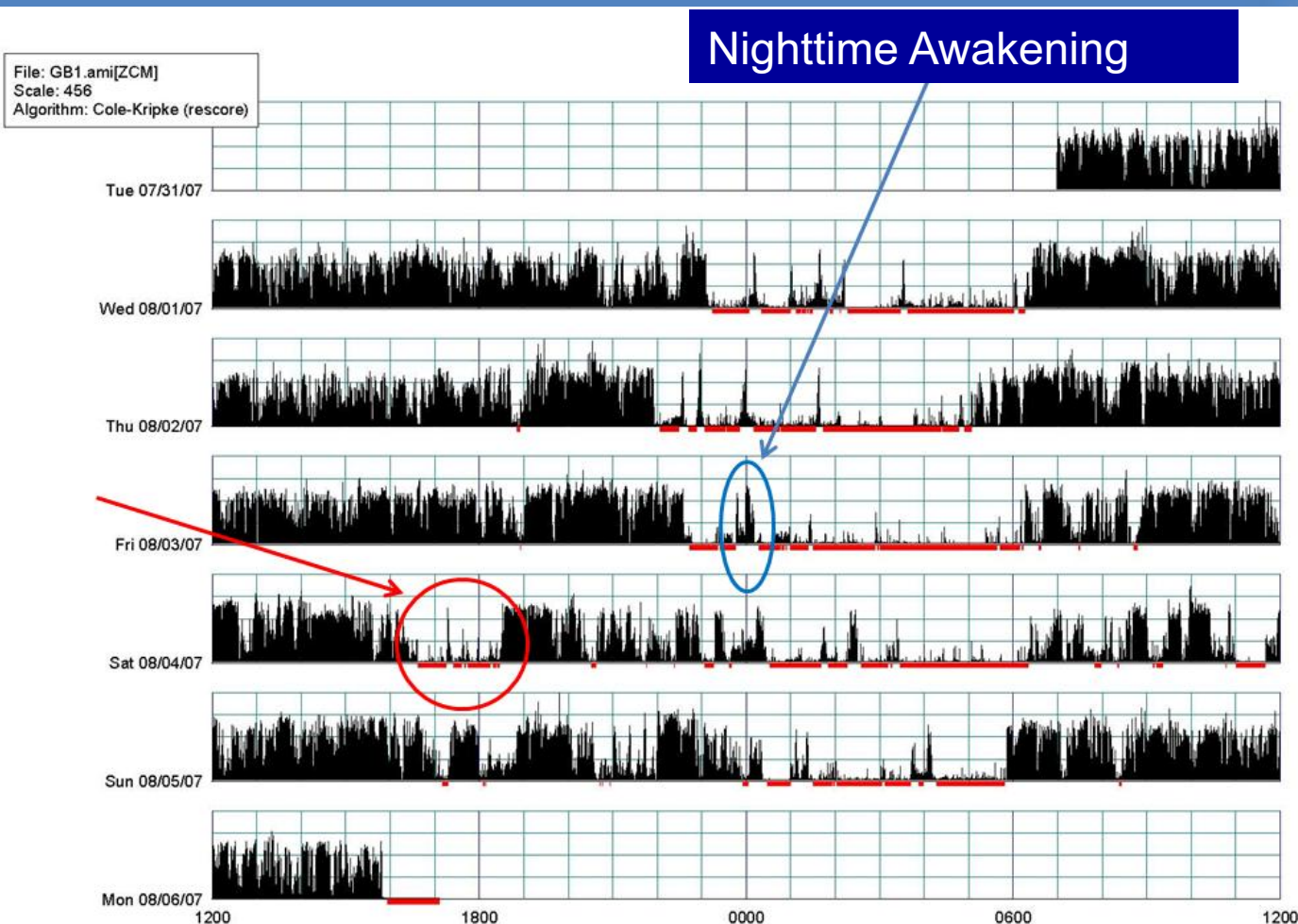
Advantages

- More objective than parent report and/or sleep diaries.
- Assessment of sleep-wake patterns for days to weeks.
- Assess sleep-wake patterns in the “natural” environment.
- Less expensive and less intrusive than overnight polysomnography.

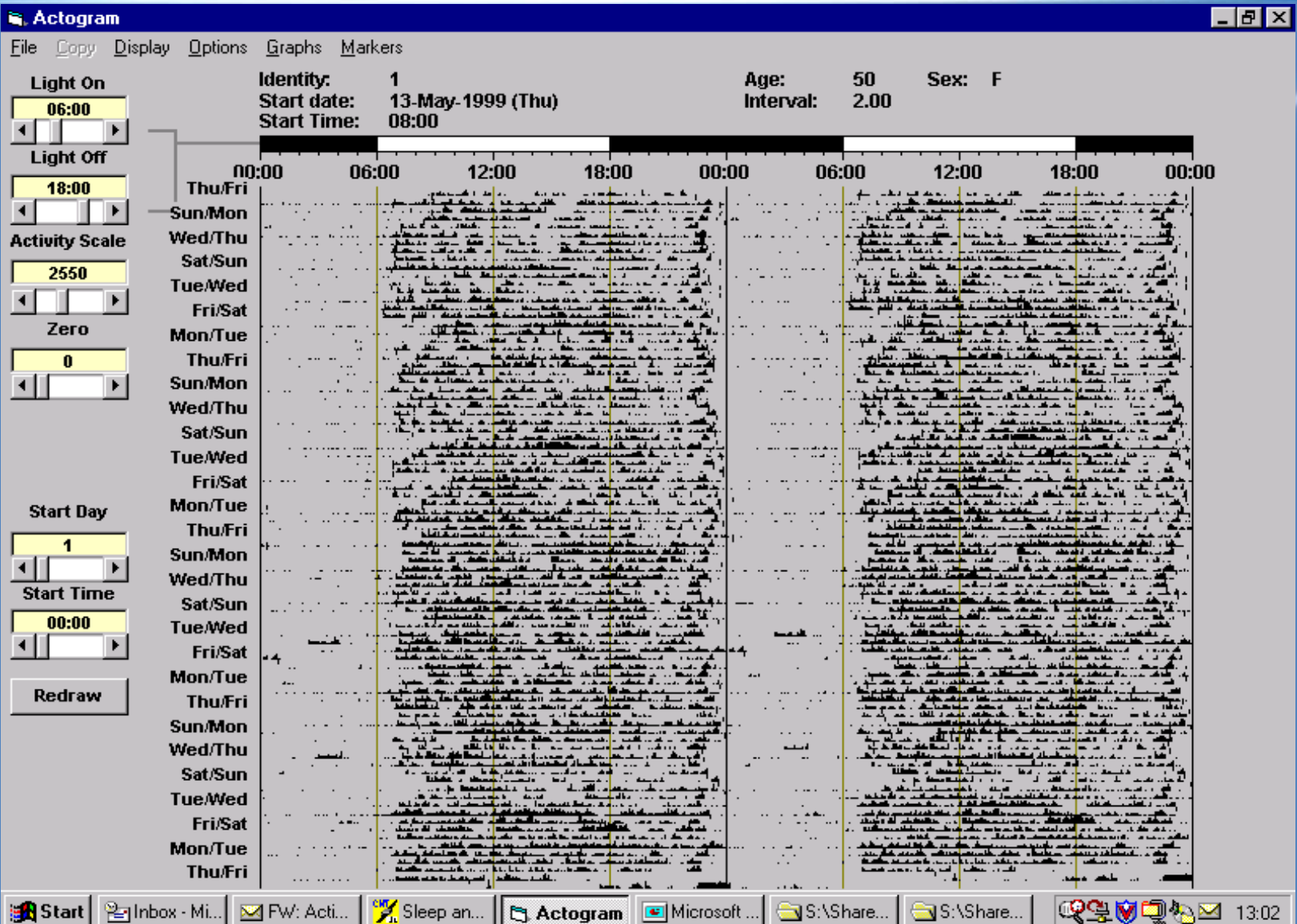
Disadvantages

- Does not provide data on sleep stage or cardio-respiratory events.
- Can not be used to diagnose sleep disorders (e.g., sleep disordered breathing, periodic limb movement disorder, narcolepsy).
- Lost data (patient adherence, technical problems, equipment failure)

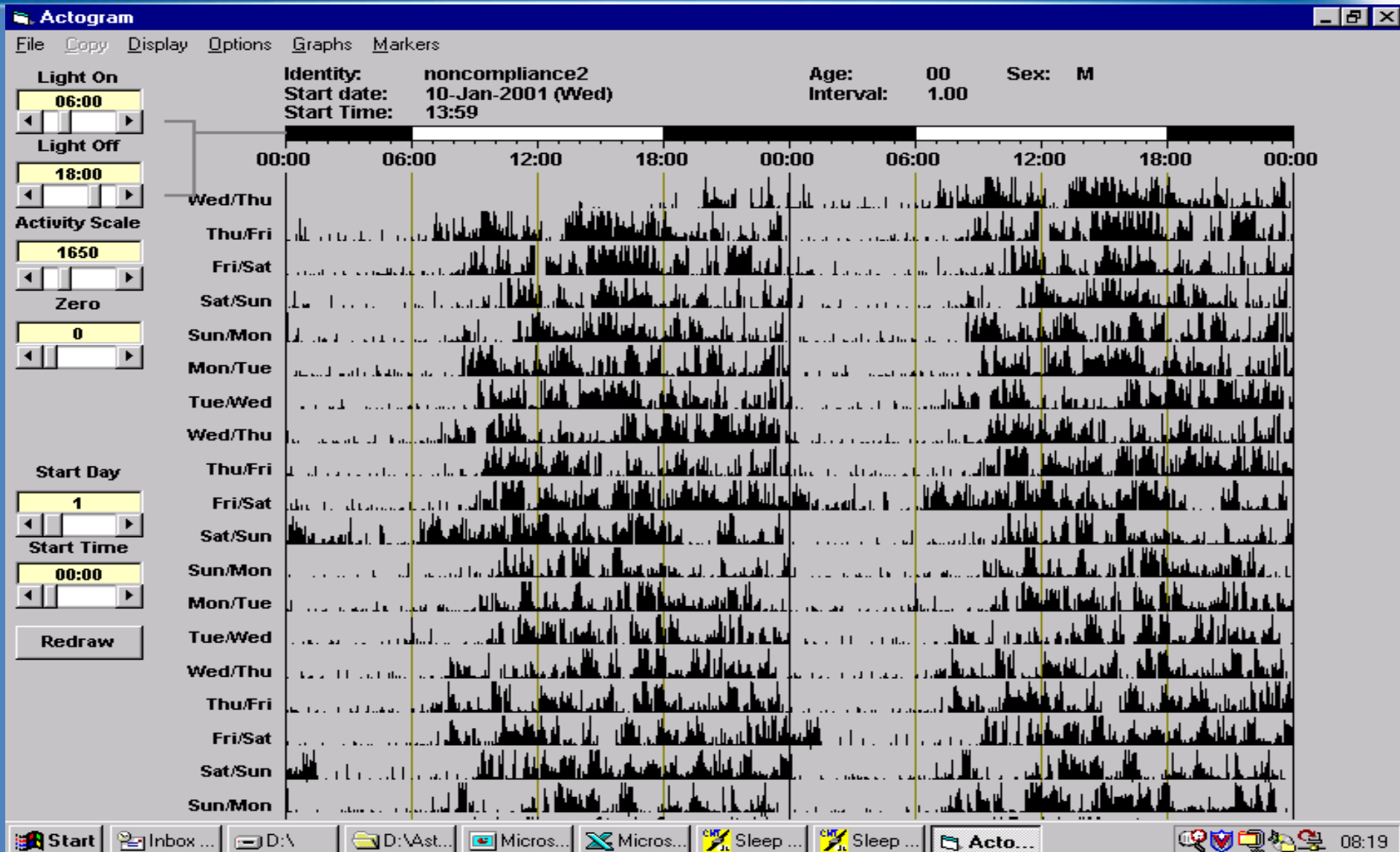
Actigraph Data Scored to Generate Sleep/Wake History



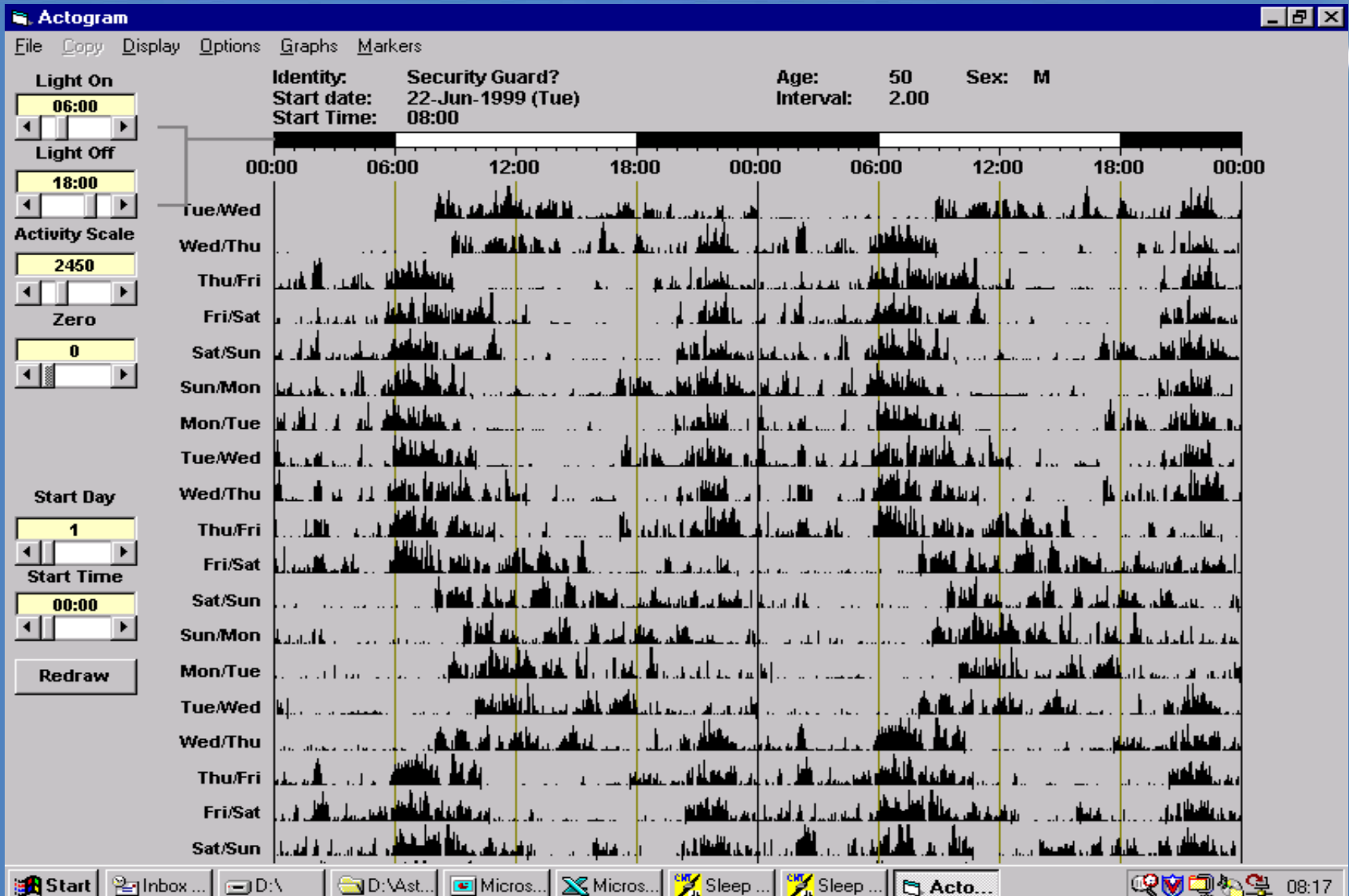
Typical Actogram



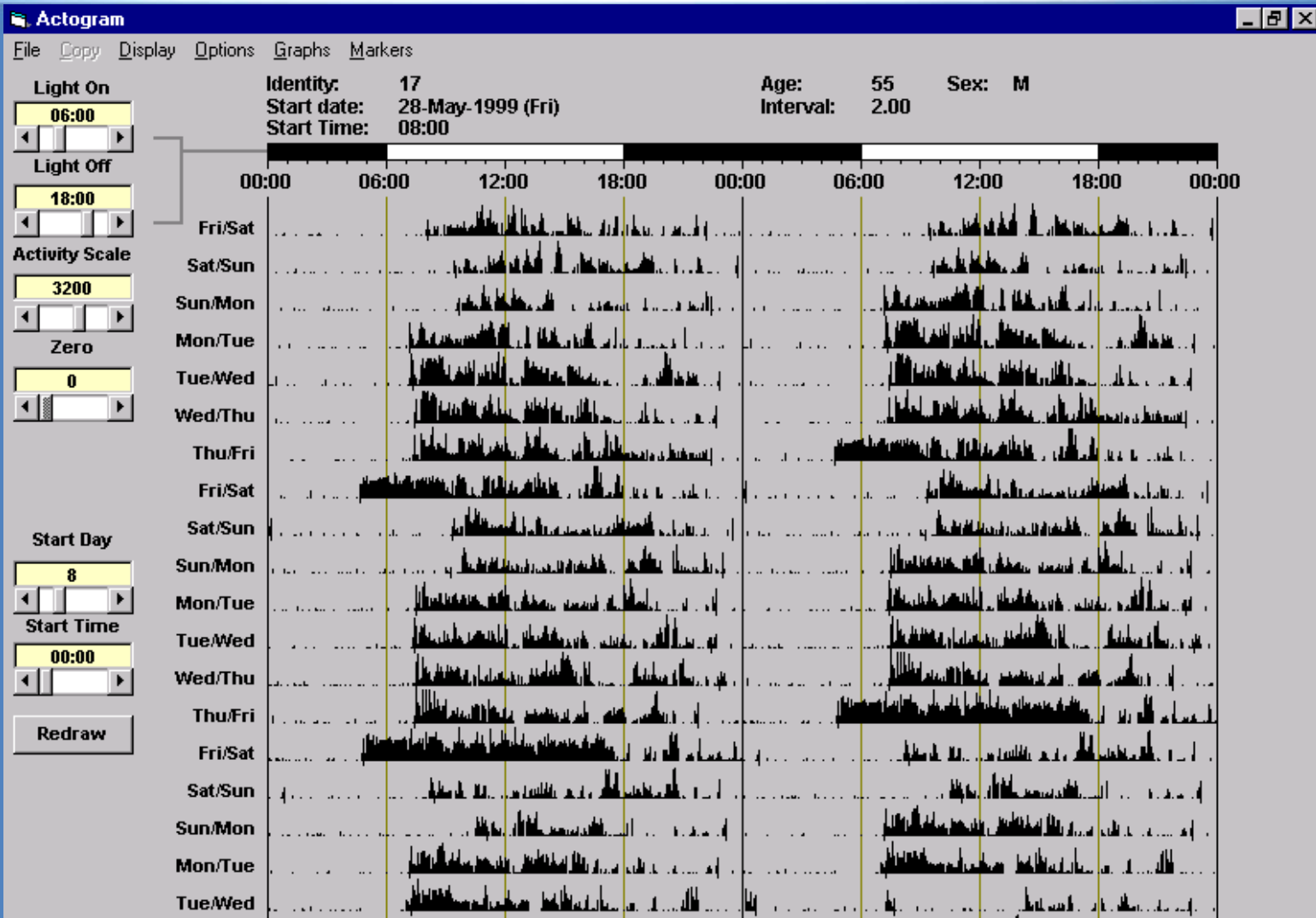
Normal Actogram



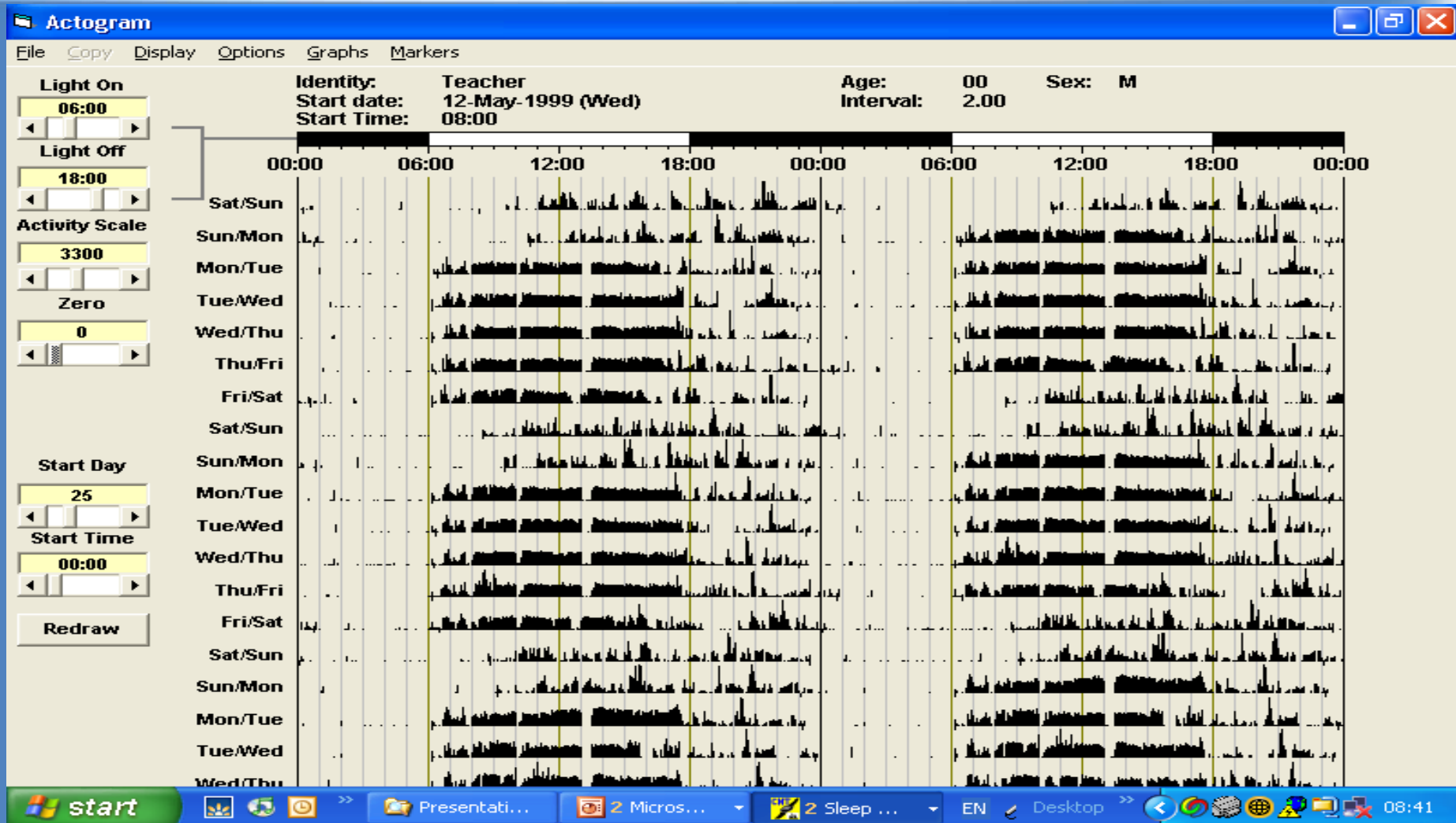
Shiftworker



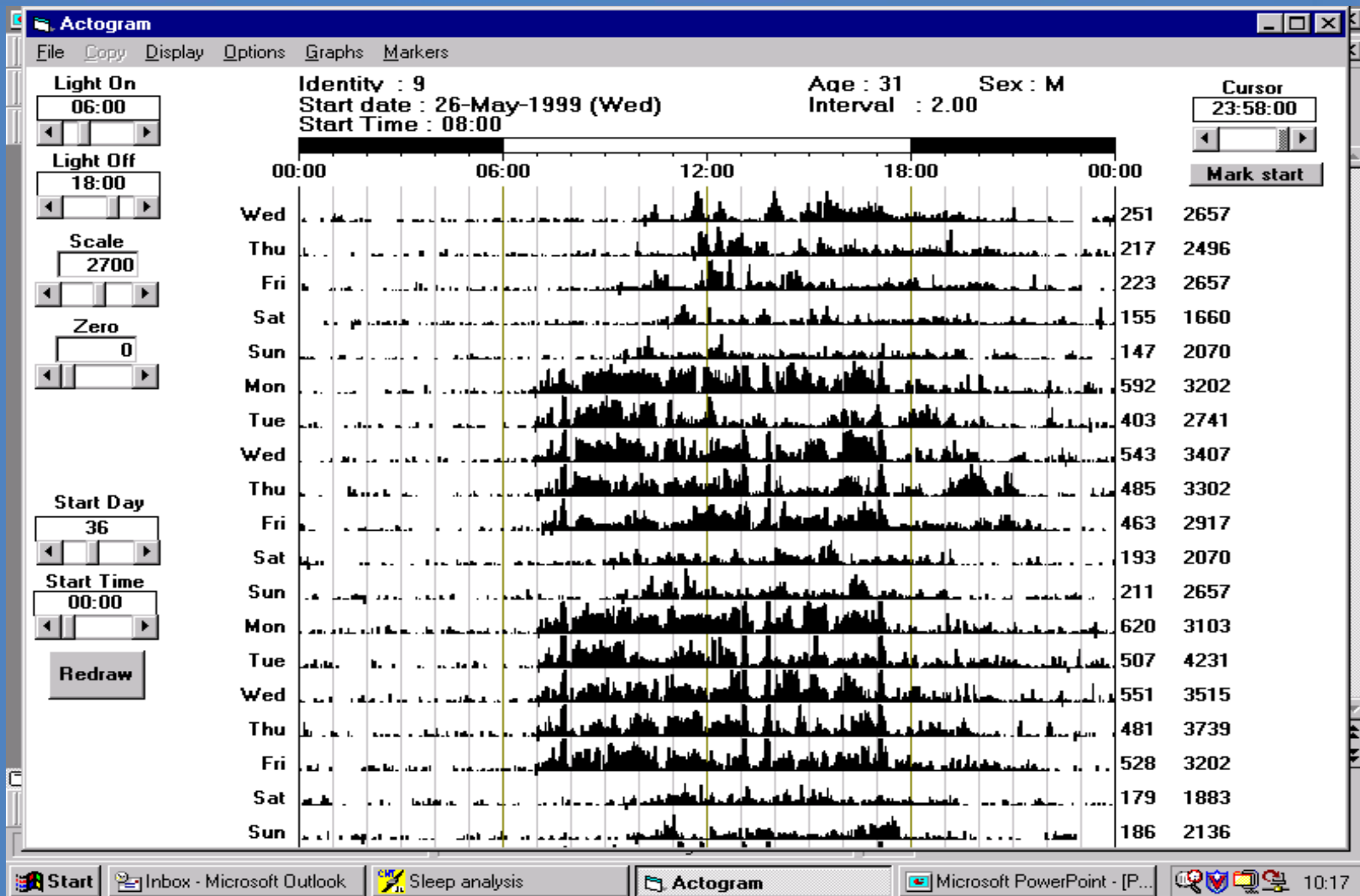
Fishing



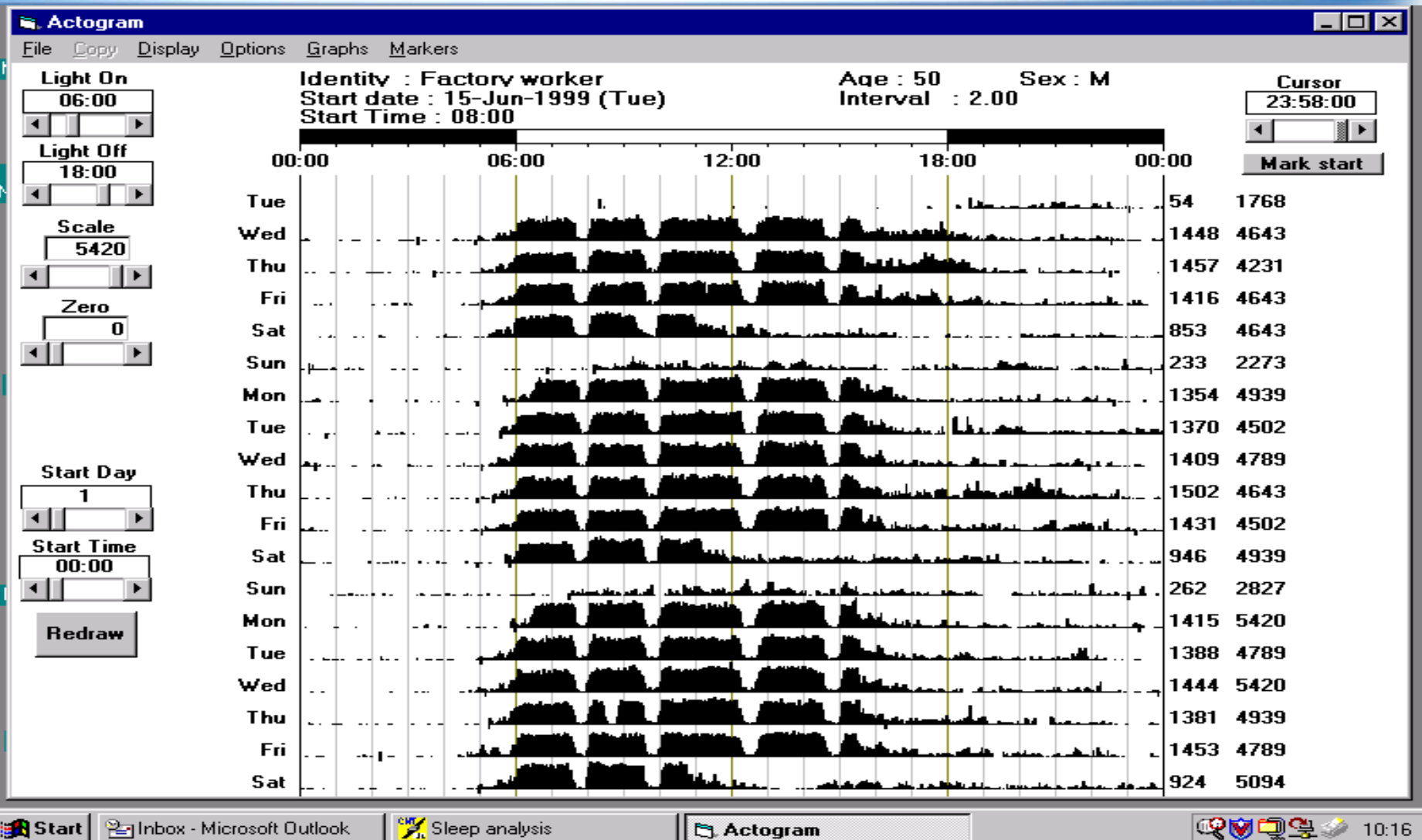
Teacher



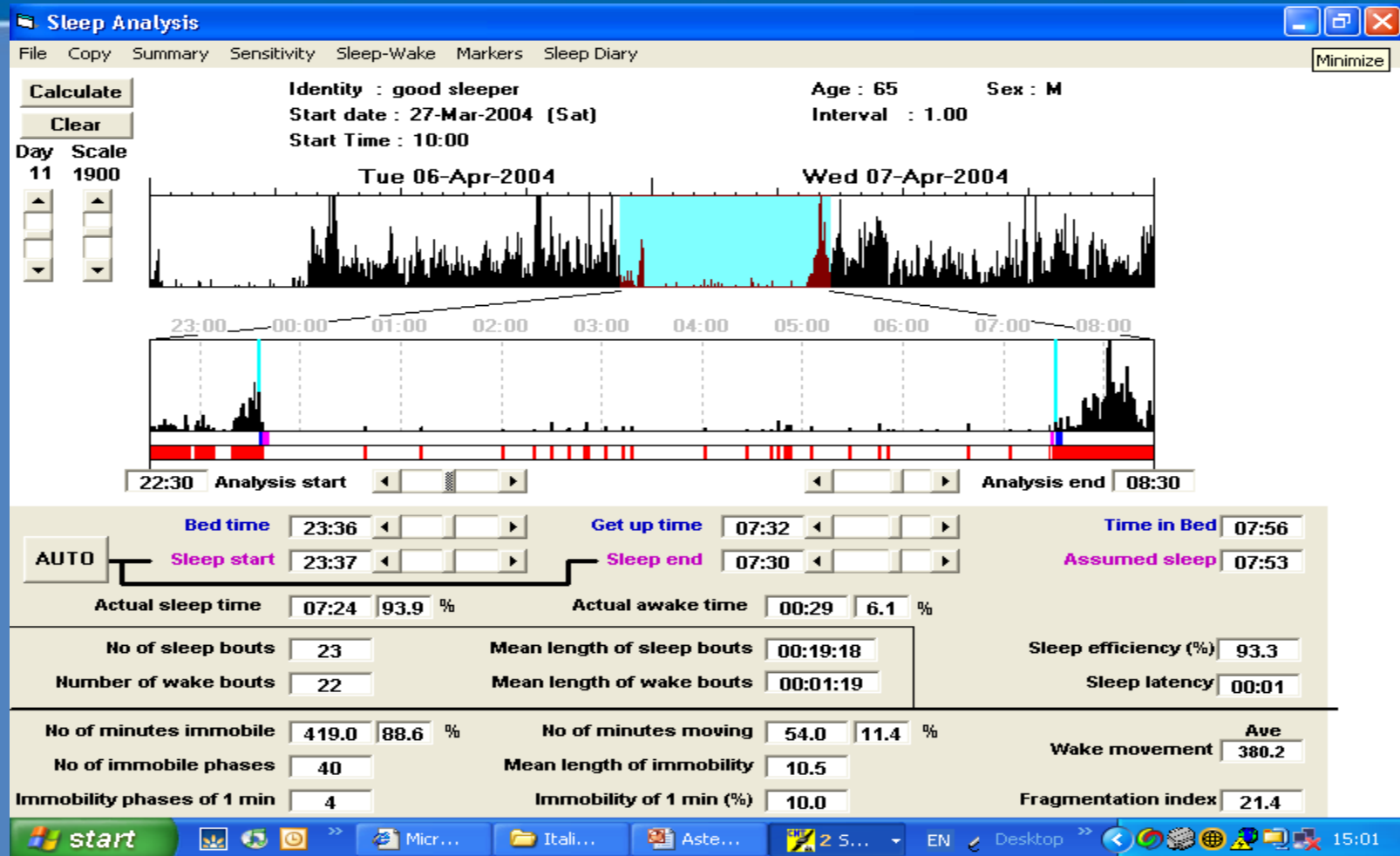
New Job



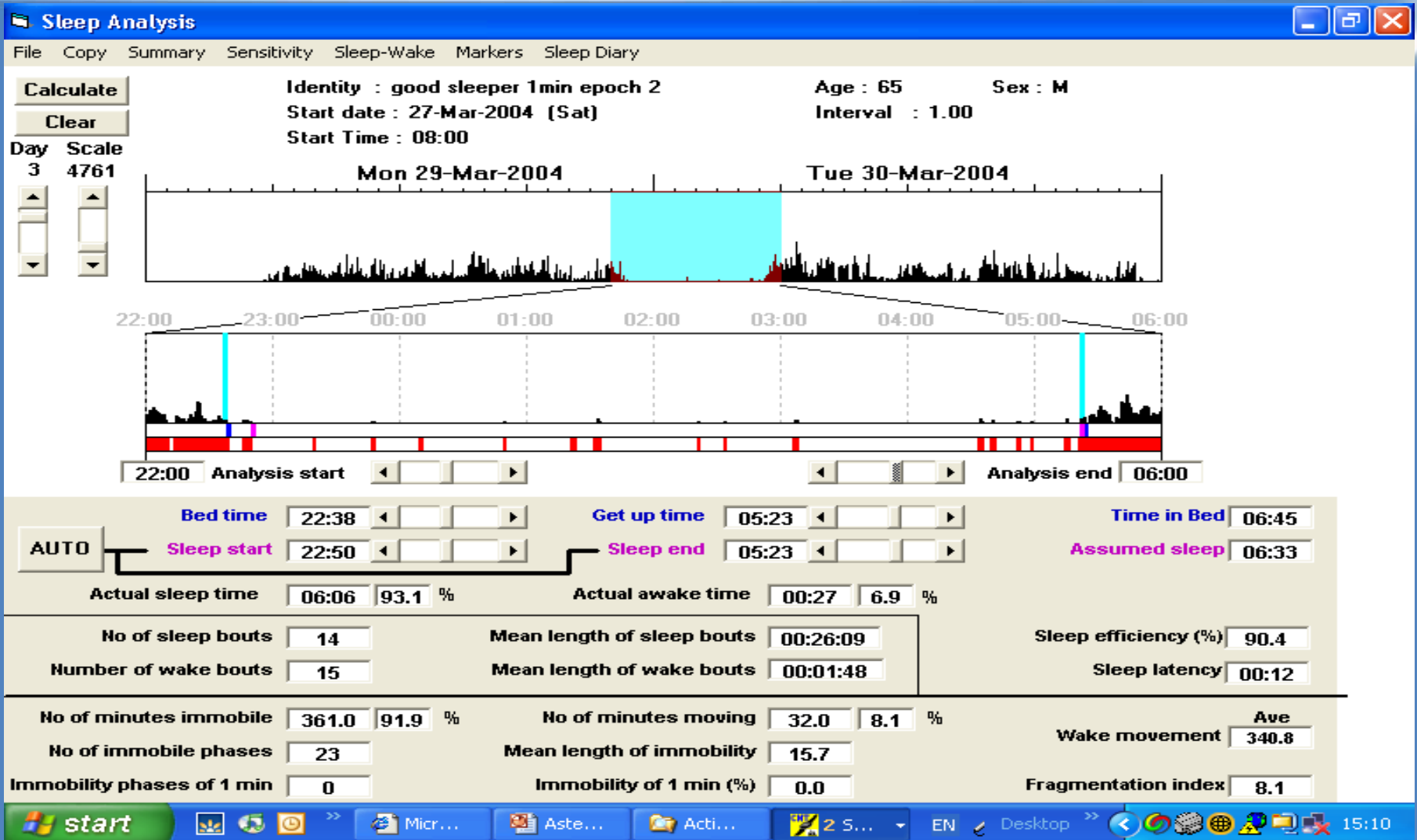
Factory Worker



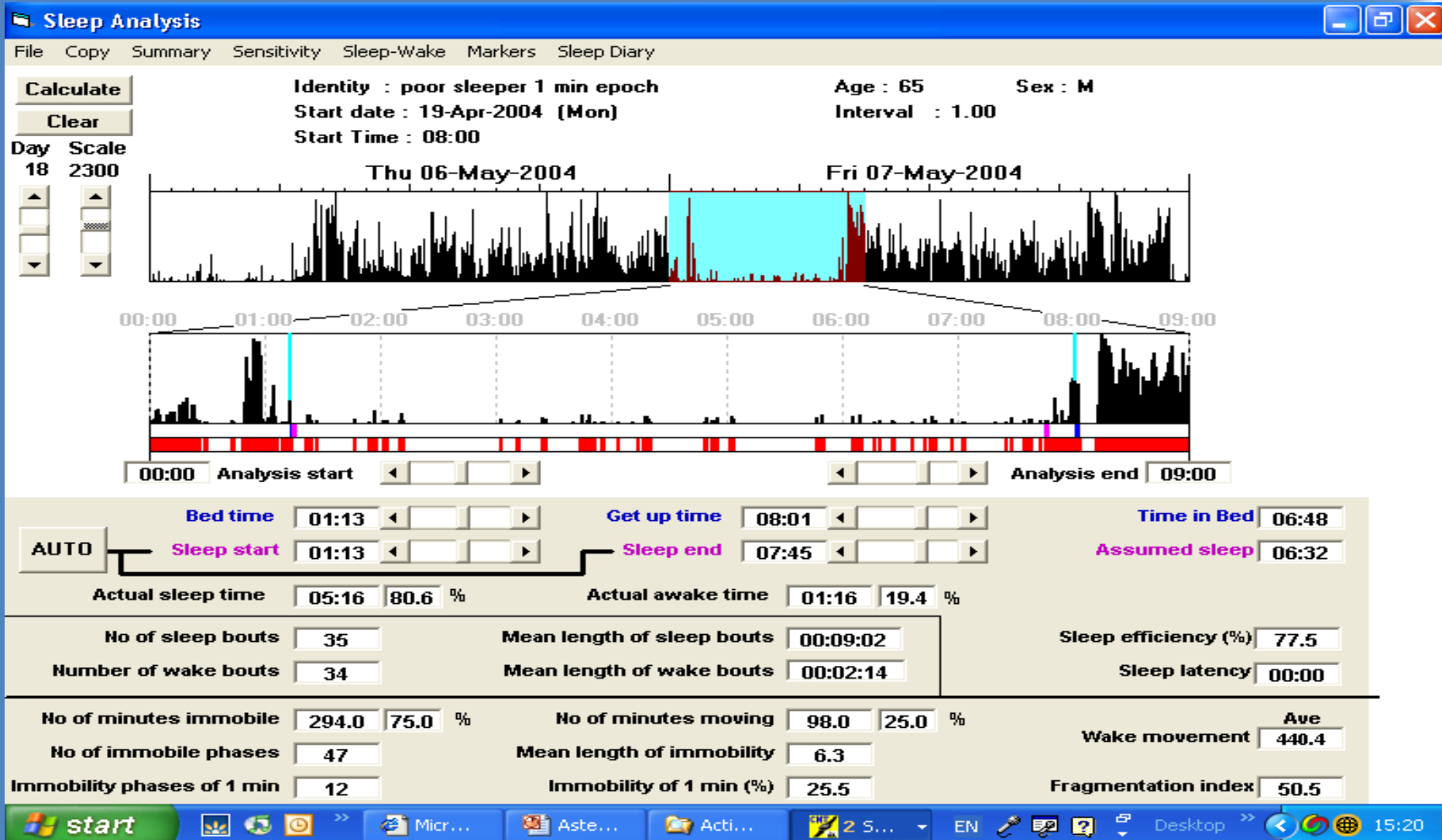
Sleep Analysis



Good Sleeper



Poor Sleeper



Date	03-Jul-09	04-Jul-09	05-Jul-09	06-Jul-09
Bed time	02:11	02:14	02:59	02:29
Get up time	07:44	10:45	07:35	06:31
Time in bed	05:33	08:31	04:36	04:02
Sleep start	02:16	02:15	03:04	02:35
Sleep end	07:44	10:23	07:29	06:30
Assumed sleep	05:28	08:08	04:25	03:55
Actual sleep time	05:05	07:42	04:12	03:36
Actual sleep (%)	93	94.7	95.1	91.9
Actual wake time	00:23	00:26	00:13	00:19
Actual wake (%)	7	5.3	4.9	8.1
Sleep efficiency	91.6	90.4	91.3	89.3
Sleep latency	00:05	00:01	00:05	00:06
Sleep bouts	12	17	10	8
Wake bouts	12	17	10	8
Mean sleep bout time	00:25:25	00:27:11	00:25:12	00:27:00
Mean wake bout time	00:01:55	00:01:32	00:01:18	00:02:22
Immobile mins	304	462	246	220
Immobile time (%)	92.7	94.7	92.8	93.6
Moving mins	24	26	19	15
Moving time (%)	7.3	5.3	7.2	6.4
No of immobile phases	21	23	17	11
Mean length immobility	14.5	20.1	14.5	20
One Minute immobility	1	2	0	0
One Min immobility (%)	4.8	8.7	0	0
Total activity score	2401	2232	1059	1759
Mean activity score	7.32	4.57	4	7.49
Mean score in active periods	100.04	85.85	55.74	117.27
Fragmentation index	12.1	14	7.2	6.4
Avg wake movement	114.1	394.6	152.2	161.4

Consumer Wearables



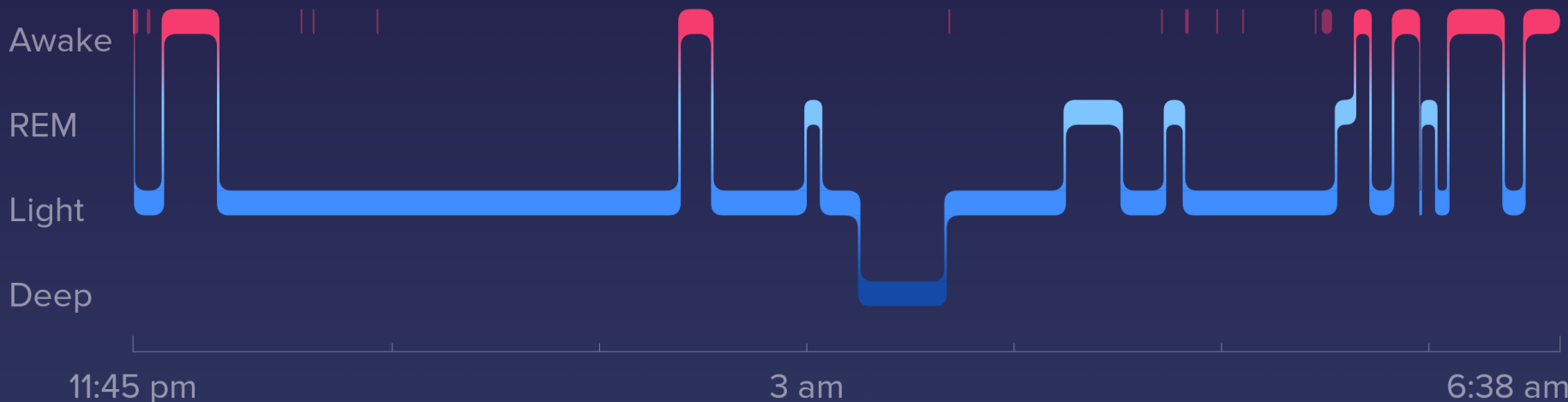


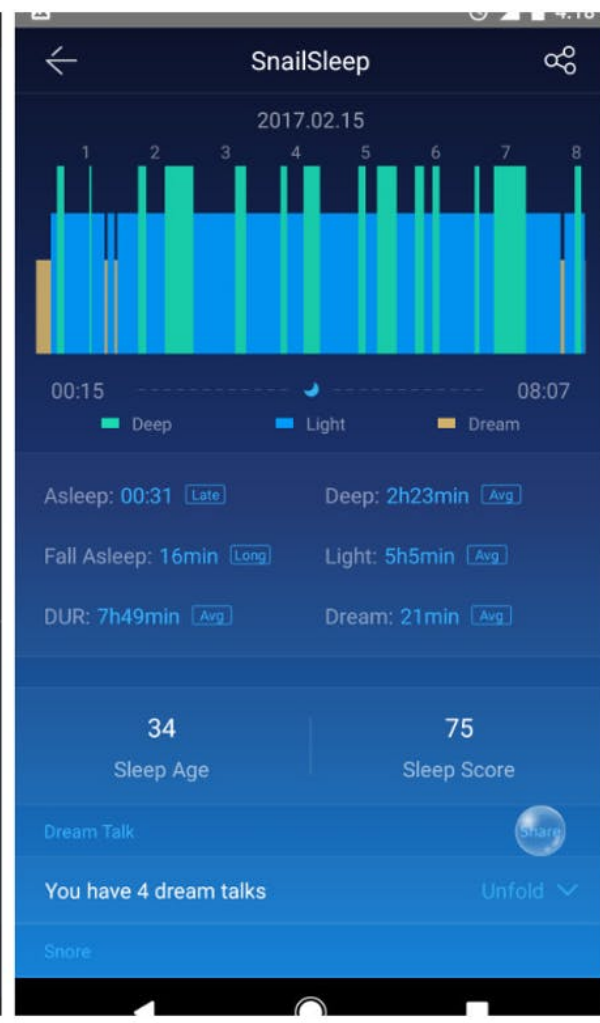
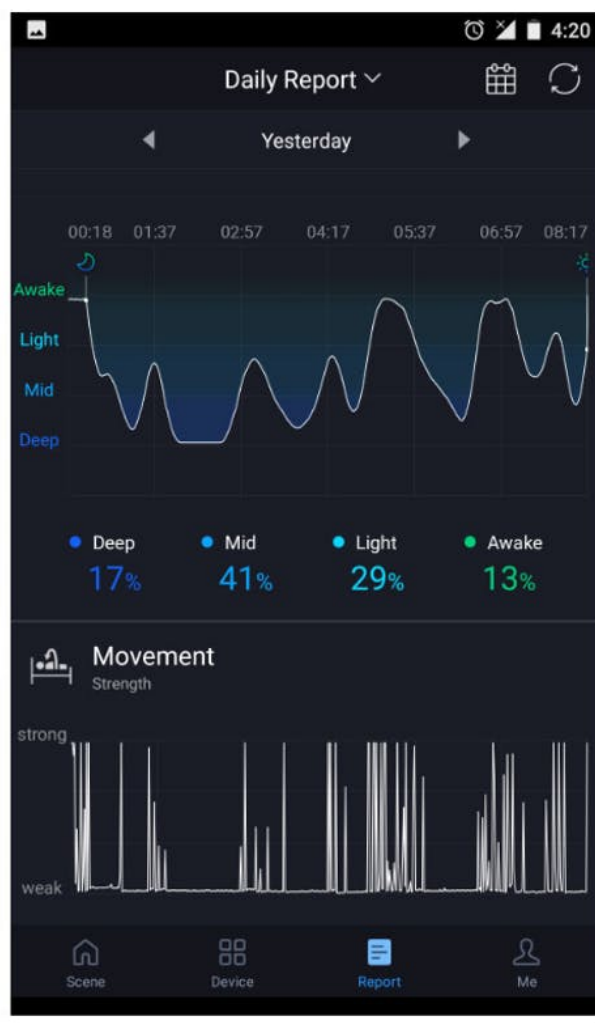
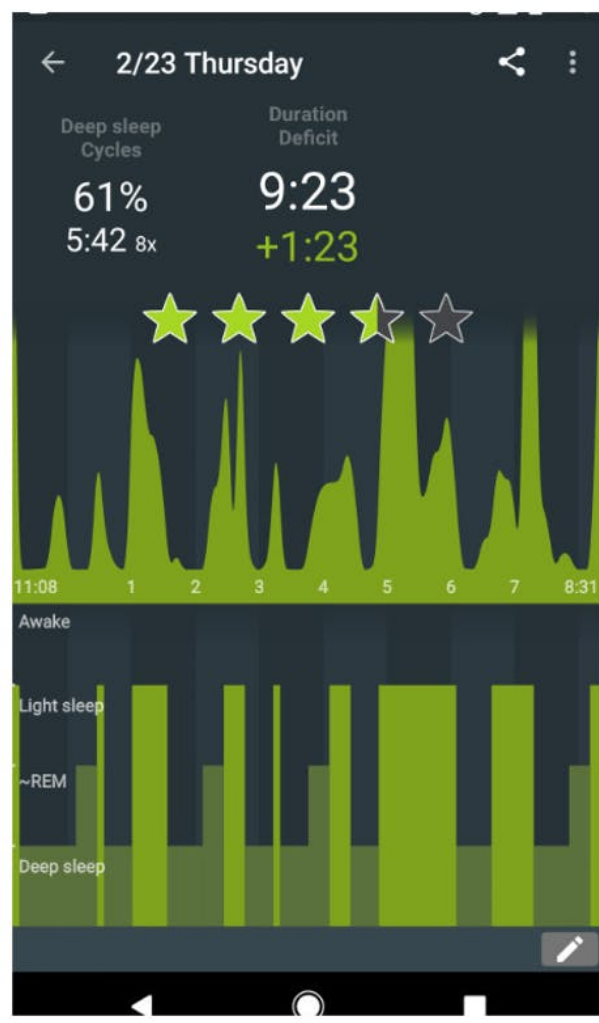
Bluetooth, Wi-Fi, cellular signal, 95% battery, 8:00 AM

Sleep Stages

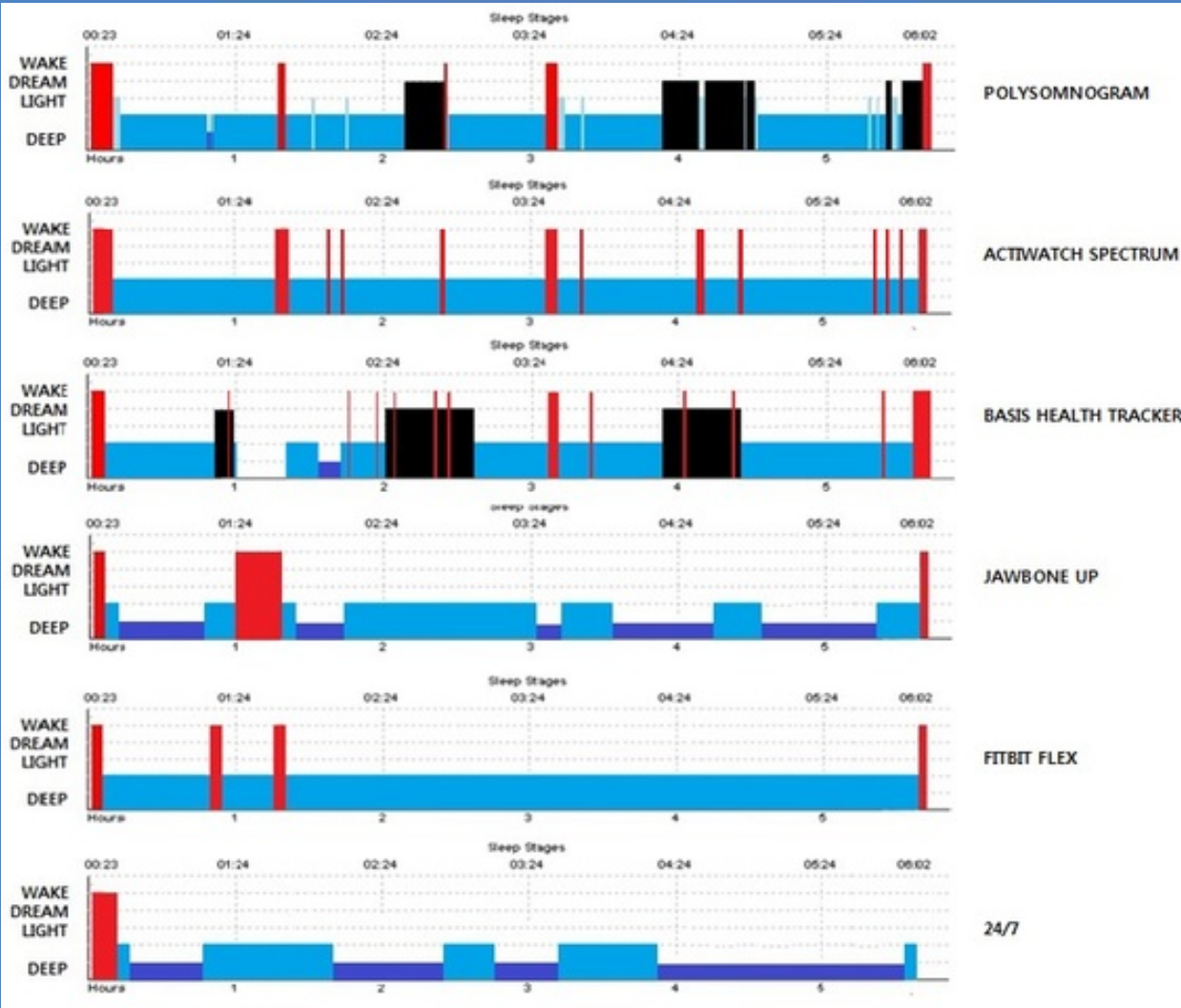
Today

Awake	REM	Light	Deep
17%	8%	67%	6%
1h 14m	37m	4h 37m	25m





Sleep trackers



Sleep trackers
overestimate total
sleep time and sleep
efficiency and
underestimate WASO

de Zambotti *SLEEP*, Vol. 38, No. 9, 2015

Sleep Diary

TWO WEEK SLEEP DIARY

INSTRUCTIONS:

1. Write the date, day of the week, and type of day: Work, School, Day Off, or Vacation.
2. Put the letter "C" in the box when you have coffee, cola or tea. Put "M" when you take any medicine. Put "A" when you drink alcohol. Put "E" when you exercise.
3. Put a line (I) to show when you go to bed. Shade in the box that shows when you think you fell asleep.
4. Shade in all the boxes that show when you are asleep at night or when you take a nap during the day.
5. Leave boxes unshaded to show when you wake up at night and when you are awake during the day.



SAMPLE ENTRY BELOW: On a Monday when I worked, I jogged on my lunch break at 1 PM, had a glass of wine with dinner at 6 PM, fell asleep watching TV from 7 to 8 PM, went to bed at 10:30 PM, fell asleep around Midnight, woke up and couldn't get back to sleep at about 4 AM, went back to sleep from 5 to 7 AM, and had coffee and medicine at 7:00 in the morning.

Today's Date	Day of the week	Type of Day Work, School, Off, Vacation	Noon	1PM	2	3	4	5	6PM	7	8	9	10	11PM	Midnight	1AM	2	3	4	5	6AM	7	8	9	10	11AM
sample	Mon.	Work		E					A				I									M	C			

week 1
week 2

Sleep diaries

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sample	Mon.	Work		E					A				I									C	M			

2/2	mon	work											I									C				
3/2	Tues	work											I									C				
4/2	Wed	work								A			I									C				
5/2	Thurs	work								E			I									C				
6/2	Fri	work								A	A			I											C	
7/2	SAT	off		A						A	A	A		I											C	
8/2	SUN	off											I									C				

week 1
week 2

Sleep Diary

Sample		
Today's date	4/5/11	
1. What time did you get into bed?	10:15 p.m	
2. What time did you try to go to sleep?	11:30 p.m	
3. How long did it take you to fall asleep?	55 min.	
4. How many times did you wake up, not counting your final awakening?	3 times	
5. In total, how long did these awakenings last?	1 hour 10 min.	
6. What time was your final awakening?	6:35 a.m.	
7. What time did you get out of bed for the day?	7:20 a.m	
8. How would you rate the quality of your sleep?	☐ Very poor ☒ Poor ☐ Fair ☐ Good ☐ Very good	☐ Ver ☐ Poc ☐ Fair ☐ Goo ☐ Ver
9. Comments (if applicable)	I have a cold	

The PSQI Structure

- It consists of **19 self rated questions**
- Grouped into **7 components**
 - subjective sleep quality,
 - sleep latency,
 - sleep duration,
 - habitual sleep efficiency,
 - sleep disturbances,
 - use of sleeping medications and
 - daytime dysfunction.
- Each component is scored separately, weighted equally on a **0 – 3 scale**.

The PSQI Structure

- The scores of the 7 components are then added to give **a global PSQI score, which has a range of 0 – 21** with **higher scores indicating worse sleep quality**.
- Three of the components are measured by one question, two components by 2 questions, one component by 3 and one by 9.

Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. **Please answer all questions.**

1. During the past month, what time have you usually gone to bed at night? _____
2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night? _____
3. During the past month, what time have you usually gotten up in the morning? _____
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.) _____



5. During the <u>past month</u> , how often have you had trouble sleeping because you...	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe:				

6. During the past month, how often have you taken medicine to help you sleep (prescribed or “over the counter”)?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
	No problem at all	Only a very slight problem	Somewhat of a problem	A very big problem
8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?				
	Very good	Fairly good	Fairly bad	Very bad
9. During the past month, how would you rate your sleep quality overall?				

The seven components

Component 1: Subjective sleep quality = Score Q6

Q6. During the past month, how would you rate your sleep quality overall?

Very good _____ Fairly good _____ Fairly bad _____ Very bad _____

Component 2: Sleep latency = Score Q2 + Score Q5a

Q2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

NUMBER OF MINUTES _____

1 ≤ 15 , 2 16 – 30, 3 31 – 60, 4 > 60

Q5. During the past month, how often have you had trouble sleeping because you . . .

a) Cannot get to sleep within 30 minutes

0	If sum = 0
1	If sum = 1 – 2
2	If sum = 3 – 4
3	If sum = 5 – 6

Component 3: Sleep duration = Score Q4

Q4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)

HOURS OF SLEEP PER NIGHT _____

0 > 7, 1 6 – 7, 2 5 – 6, 3 < 5

Component 4: Habitual Sleep Efficiency =
$$\frac{\text{Score } Q4}{\text{Score } Q3 - \text{Score } Q1} = \dots\dots\%$$

0 If >= 85%, 1 75 – 84% 2 65 – 74% 3 < 65%

Component 5: Sleep Disturbances = Sum of score Q5b, ..., Q5j (9 items)

0	If sum = 0
1	If sum = 1 – 9
2	If sum = 10 – 18
3	If sum = 19 – 27

Component 6: Use of Sleep Medication = Score Q7

Q7. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?

Component 7: Daytime Dysfunction = Score Q8 + Score Q9

Q8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Q9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

0	If sum = 0
1	If sum = 1 – 2
2	If sum = 3 – 4
3	If sum = 5 – 6

LSEQ

- The Leeds Sleep Evaluation Questionnaire (LSEQ) was designed to measure the self-reported effects of psychoactive drugs on sleep and awakening (Hindmarch, 1975).
- It is the only sleep questionnaire that was specifically designed with the pharmaceutical industry in mind for use in clinical trials.
- It is one of the only sleep questionnaires specifically designed to measure change.



LSEQ

- The LSEQ It is a retrospective instrument by which the patients are asked to contrast aspects of their current sleep with those at the time before they were enrolled in the study.
- The LSEQ, is designed to be used in a repetitive manner, yielding a series of measurements and the difference between current and preceding measurements are used in drug efficacy evaluations. (Zisapel and Laudon, 2003).



LSEQ

The LSEQ is composed of 10 items investigating 4 domains.

- The ease of getting to sleep (GTS)
- The perceived quality of sleep (QOS)
- The ease of awakening from sleep (AFS)
- The integrity of behaviour following wakefulness (BFW)



Getting To Sleep (GTS)

How would you compare getting to sleep last night with getting to sleep normally?

- | | | |
|----|-----------------------------|-----------------------------|
| 1. | Easier than usual | Harder than usual |
| 2. | Quicker than usual | Slower than usual |
| 3. | Felt more drowsy than usual | Felt less drowsy than usual |



The perceived quality of sleep (QOS)

- How would you compare the quality of sleep last night with your usual sleep?
- 4. More restful than usual More restless than usual
- 5. Fewer periods of wakefulness of wakefulness than usual More periods than usual



The ease of awakening from sleep (AFS)

How did your awakening this morning compare with your usual pattern of awakening?

6. Easier than usual More difficult
than usual

7. Took shorter than usual Took longer than usual

How did you feel on waking?

8. Alert Tired



The integrity of behavior following wakefulness (BFW)

How do you feel now?

9. Alert Tired

How was your sense of balance and coordination upon getting up?

10. Less clumsy than usual More clumsy than usual



Scoring Procedure

- A 10-cm line separates the 2 halves of each question.
- Each question is answered by placing a vertical mark on the answer line. If no change was experienced then place your mark in the middle of the line. If a change was experienced then the position of the mark will indicate the nature and extent of the change, *i.e.* large changes near the ends of the line, small changes near the middle.



Scoring Procedure 2

- Patients are informing that 'normal' refers that what is normal for them and not anyone else.
- They are informed that a mark half way on the line indicates no change from normal and that the length of deviation from the center indicates the extent of the difference.
- LSEQ should be administrated 30 min after wake-up time.



Scoring Procedure 3

- Each domain is calculated and reported separately.
- There is no global score for the LSEQ.
- Even if the polarity is changed, the measure is always done from 'bad' to 'good' and reported.



Psychometric and cognitive tests

- Reaction time
- Memory
- Information processing
- Learning
- 'Hang-over' residual effects

Objective Field Measurement of Performance

Psychomotor Vigilance Test (PVT)

- 10 minute test



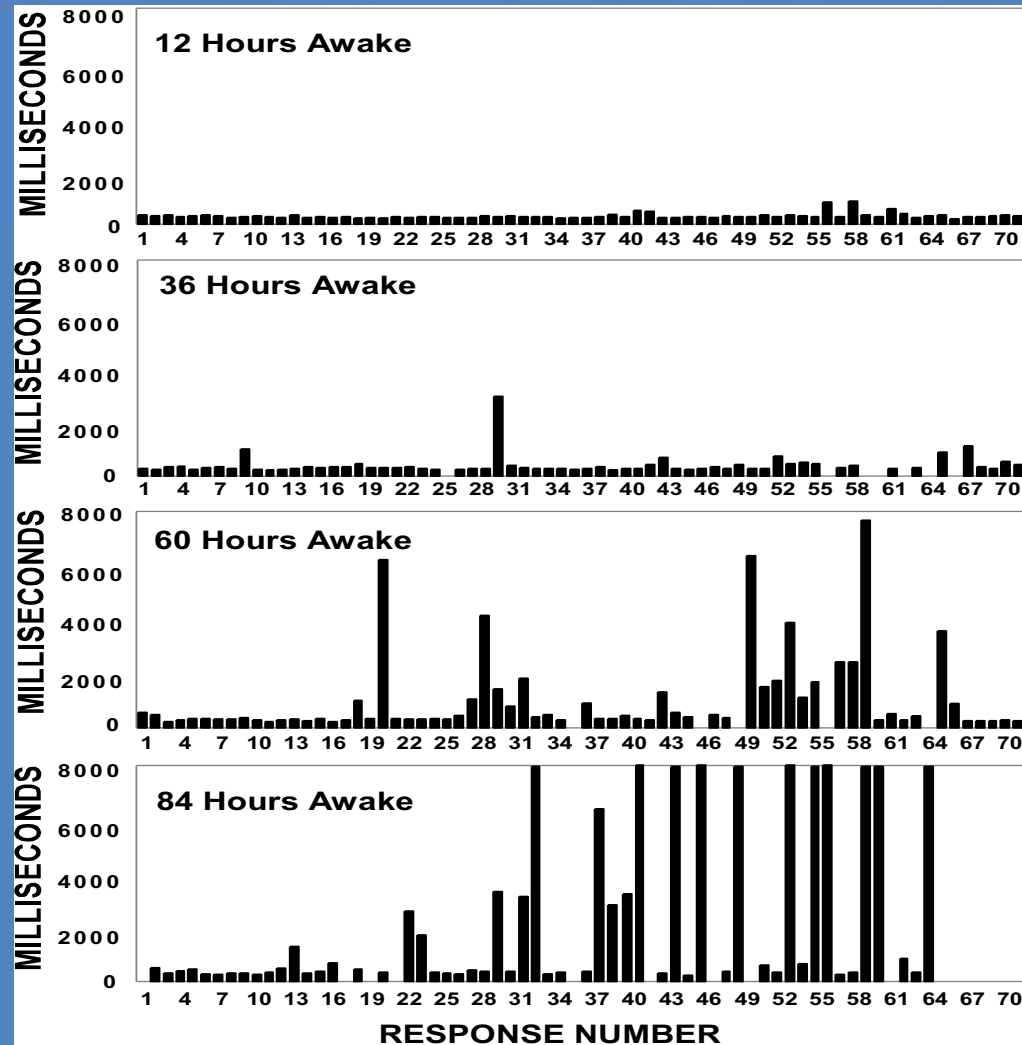
Effect of Sleep Loss on Performance on the Psychomotor Vigilance Test (PVT)

12 Hours
Awake

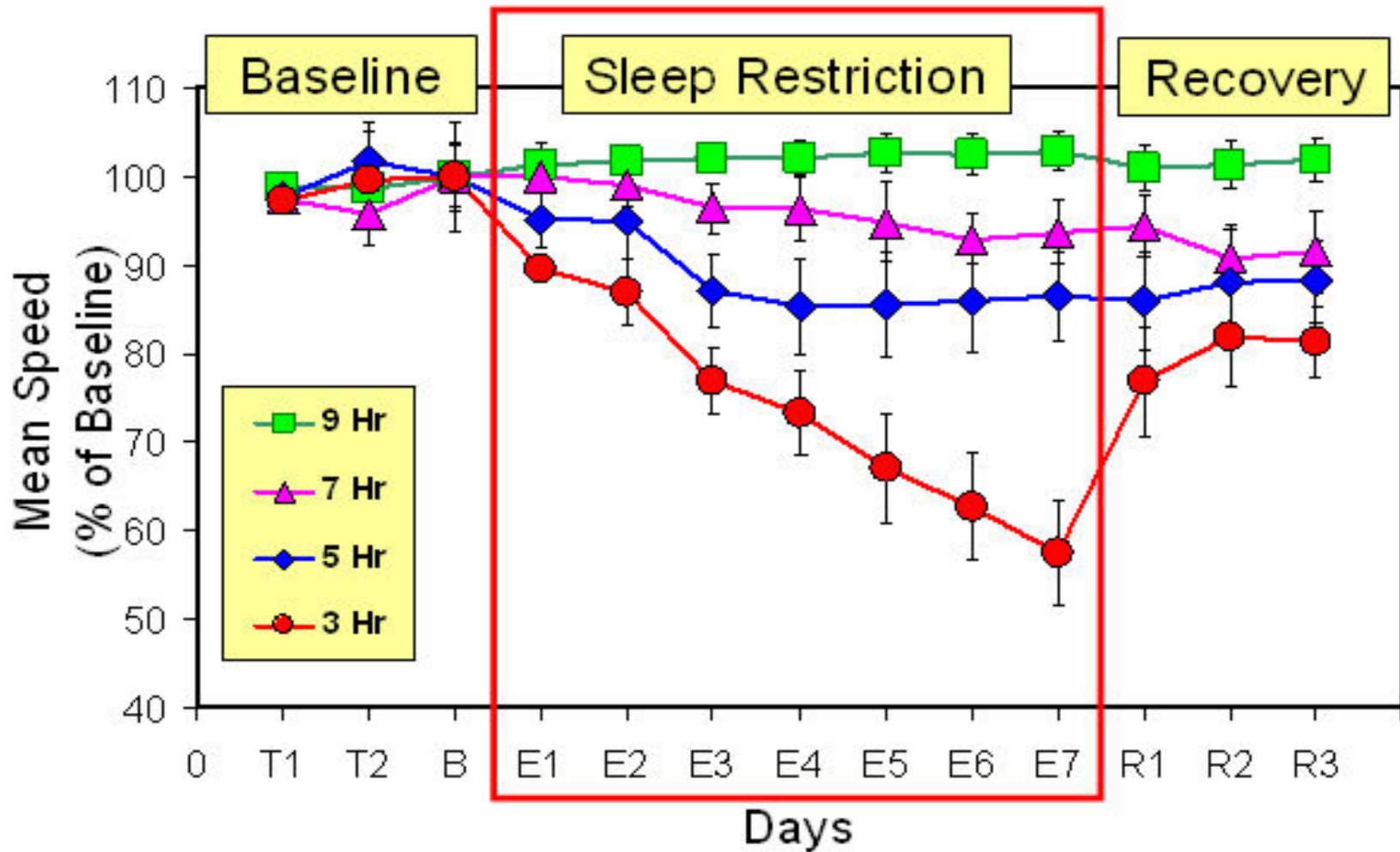
36 Hours
Awake

60 Hours
Awake

84 Hours
Awake



Psychomotor Vigilance Task Performance across Sleep Restriction and Recovery



From Belenky G, Wesensten NJ, Thorne DR, Thomas ML, Sing HC, Redmond DP, Russo MB, Balkin TJ (2003). Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study. *Journal of Sleep Research* 12: 1-12.

Daytime sedation

Karolinska Sleepiness Scale (KSS)

Extremely alert	1
Very alert	2
Alert	3
Rather alert	4
Neither alert nor sleepy	5
Some signs of sleepiness	6
Sleepy, but no effort to keep awake	7
Sleepy, but some effort to keep awake	8
Very sleepy, great effort to keep awake, fighting sleep	9
Extremely sleepy, can't keep awake	10

Daytime sedation

The Stanford Sleepiness Scale (SSS)

Degree of Sleepiness	Scale Rating
Feeling active, vital, alert, or wide awake	1
Functioning at high levels, but not at peak; able to concentrate	2
Awake, but relaxed; responsive but not fully alert	3
Somewhat foggy, let down	4
Foggy; losing interest in remaining awake; slowed down	5
Sleepy, woozy, fighting sleep; prefer to lie down	6
No longer fighting sleep, sleep onset soon; having dream-like thoughts	7
Asleep	X

Epworth Sleepiness Scale

Epworth Sleepiness Scale

How likely are you to doze off or fall asleep in the following situations, in contrast to just feeling tired?
This refers to your usual way of life in recent times.
Even if you haven't done some of these activities recently, try to work out how they would have affected you.

Use the following scale to choose the most appropriate number for each situation

0	would never doze	2	moderate chance of dozing
1	slight chance of dozing	3	high chance of dozing

It is important that you put a number (0-3) in each of the brackets

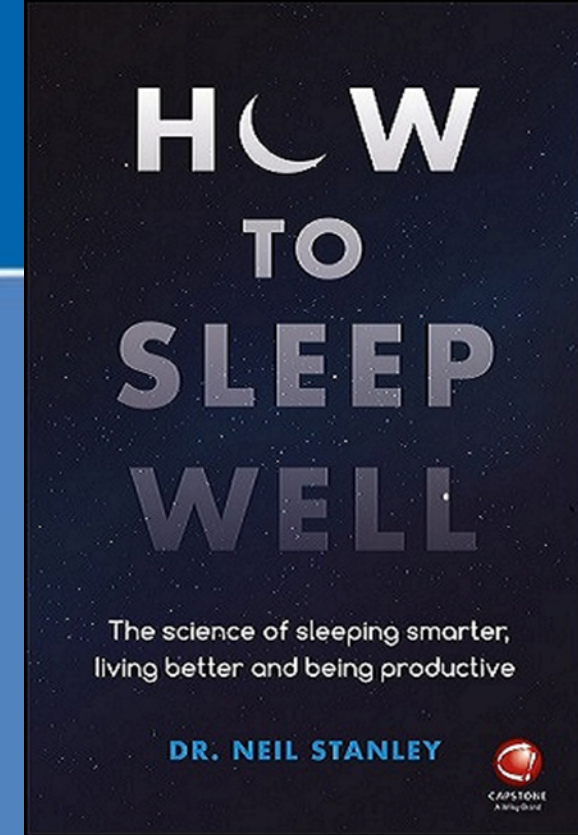
SITUATION	CHANCE of DOZING
Sitting and reading	()
Watching TV	()
Sitting inactive in a public place (eg theatre or a meeting)	()
As a passenger in a car for an hour without a break	()
Lying down to rest in the afternoon when circumstances permit	()
Sitting and talking to someone	()
Sitting quietly after lunch without alcohol	()
In a car, while stopped for a few minutes in traffic	()
	<u> </u> /24 TOTAL

How can sleep catch us best?

- Sleep-promoting sleep environment
 - Dark, moderate temperature, quiet, well-ventilated
- Quiet mind and relaxed body
- Strong association between sleep & bed
- No direct efforts toward sleep
- Absence of regular thought process about sleep



Thank you



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www.thesleepconsultancy.com