Sleep Measurement, Polysomnography, and Quantitative EEG

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PSY 501A - Psychophysiology
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Outline

- Defining sleep
- Subjective measures
- Objective measures
  - o Polysomnography (PSG)
  - o Quantitative EEG for research

What is sleep?

- How do we know someone is sleeping?

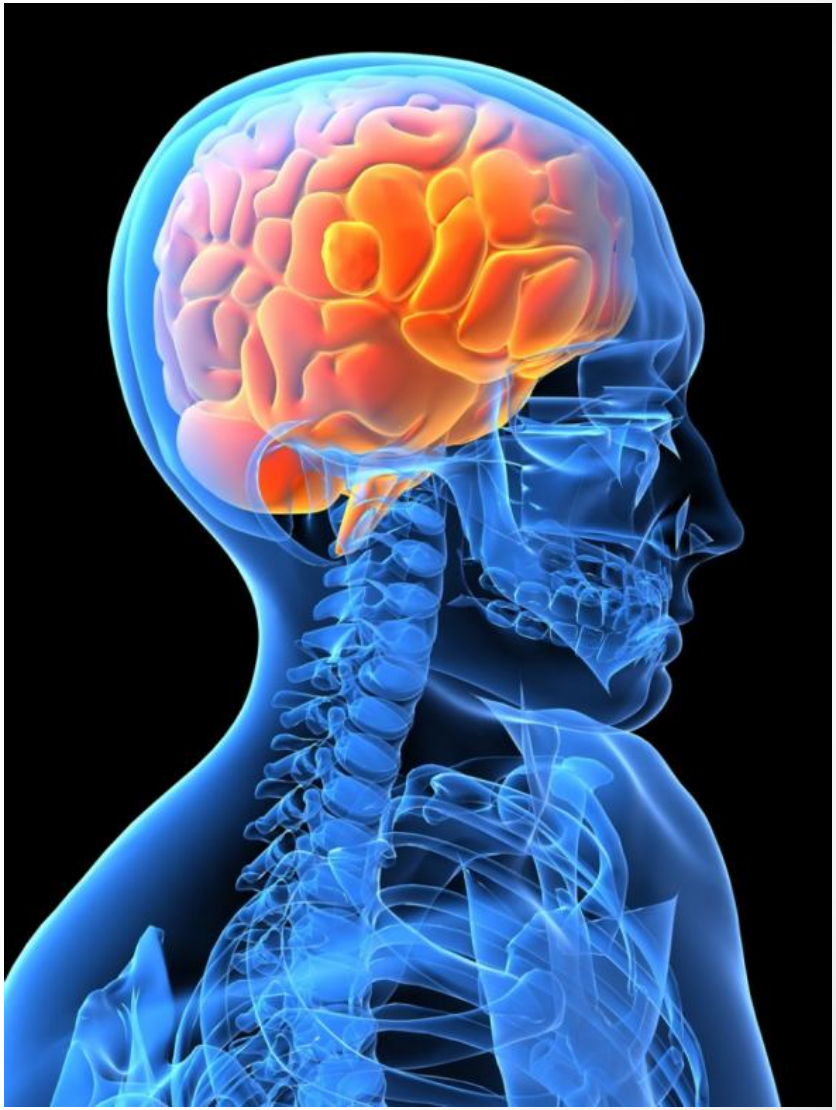
- Behavioral characteristics
- Physiological characteristics
- Homeostatic features
- Circadian features

Behavioral characteristics

- Eyes closed (usually)
- Minimal movement (except for twitches and position changes)
- Substantially decreased responsiveness and awareness of environment
- Changes to breathing patterns
- Reversible

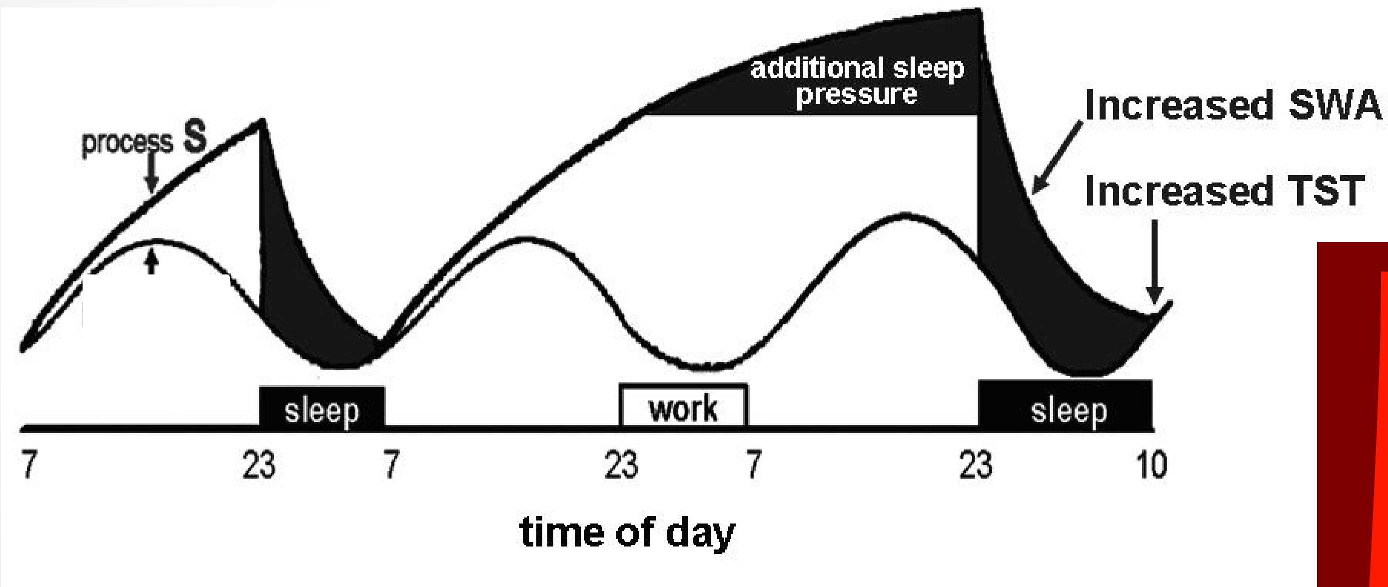
Physiological characteristics

- Body temperature
- Endocrine changes
- Brain activity
  - o Blood flow
  - o Metabolism
  - o Chemistry
  - o Electrical output



Homeostatic features

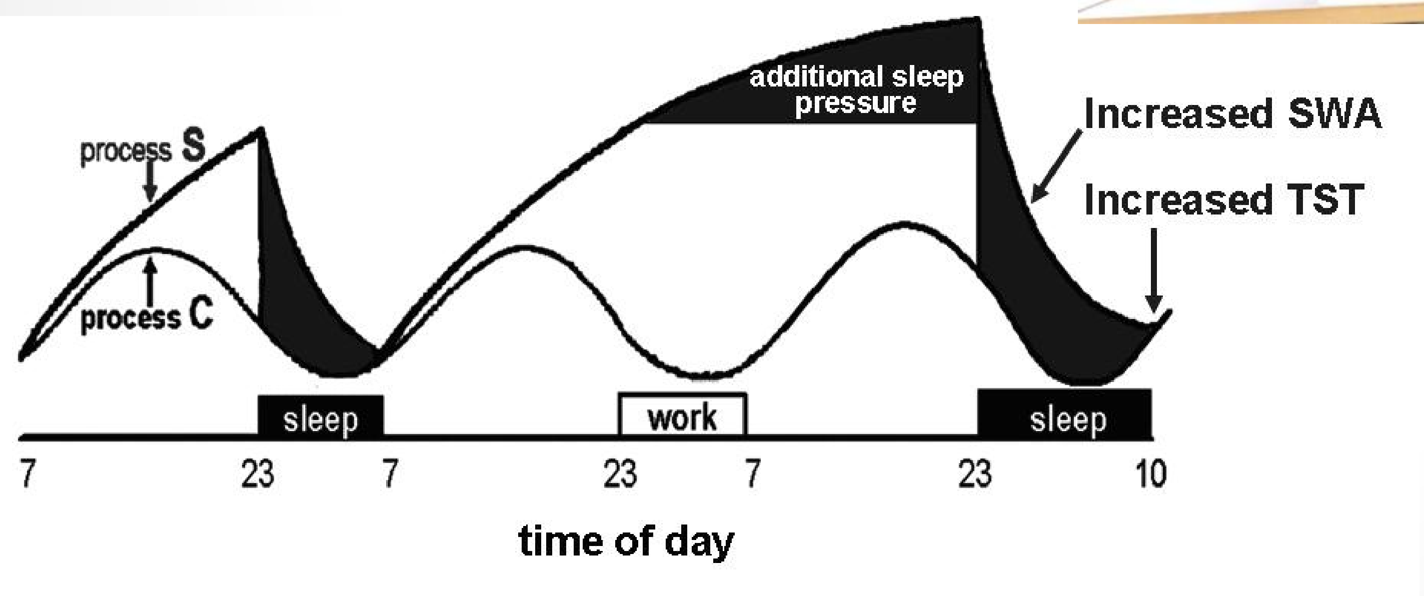
- Extended wakefulness/sleep deprivation
- Sleep “rebound”



http://smoens.wordpress.com. Adapted from Borbély & Achermann (1999)

Circadian features

- Early morning class
- Jet lag



http://smoens.wordpress.com. Adapted from Borbély & Achermann (1999)

What is sleep?

- Behavioral characteristics
- Physiological characteristics
- Homeostatic features
- Circadian features
- *Sleep vs. "sleepiness"*

Subjective measurement of sleep

- Retrospective ratings
- Sleep diary

Retrospective ratings

The 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.

During the past month,

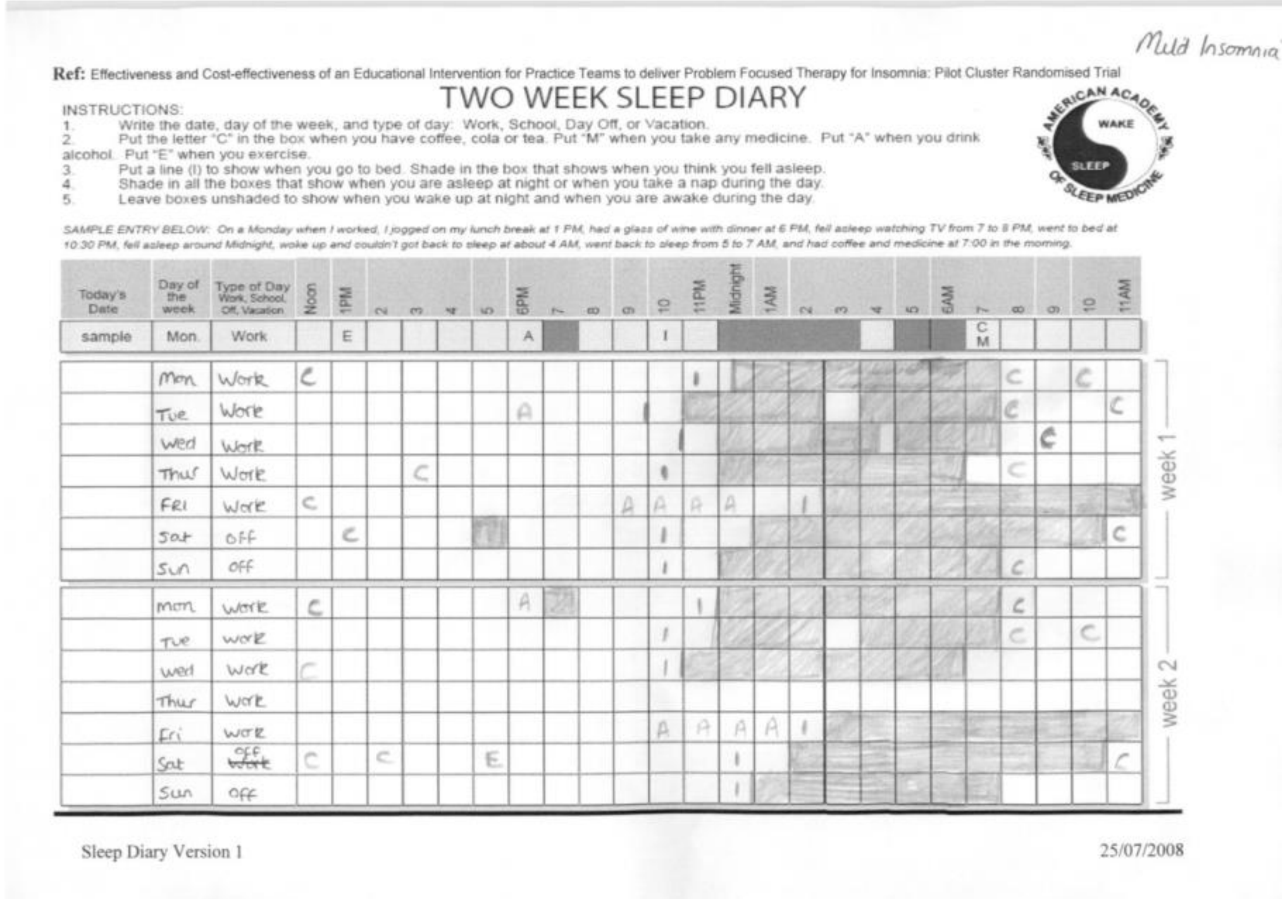
1. When have you usually gone to bed? ___________________
2. How long (in minutes) has it taken you to fall asleep each night? ___________________
3. When have you usually gotten up in the morning? ___________________
4. How many hours of actual sleep do you get at night? (This may be different than the number of hours you spend in bed) ___________________

5. During the past month, how often have you had trouble sleeping because you…	Not during the past month (0)	Less than once a week (1)	Once or twice a week (2)	Three or more times week (3)
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, including how often you have had trouble sleeping because of this reason(s):				
6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?				
	Very good (0)	Fairly good (1)	Fairly bad (2)	Very bad (3)
9. During the past month, how would you rate your sleep quality overall?				

Buysse et al. (1989)

Sleep diary

	Example
Yesterday's day: Yesterday's date:	Tuesday June 24th
1. NAP (yesterday)	70 min
2. BEDTIME (last night)	10:55pm
3. TIME TO FALL ASLEEP	65 min
4. # AWAKENINGS	4
5. WAKE TIME (during night)	110 min
6. FINAL WAKE-UP	6:05 am
7. OUT OF BED	7:10 am
8. QUALITY/SATISFACTION	2
9. ALCOHOL/MEDICATION -Type -Amount -Time	 Halcion 0.25mg 10:40 pm



Mild Insomnia

Ref: Effectiveness and Cost-effectiveness of an Educational Intervention for Practice Teams to deliver Problem Focused Therapy for Insomnia: Pilot Cluster Randomised Trial

TWO WEEK SLEEP DIARY

AMERICAN ACADEMY OF SLEEP MEDICINE — WAKE — SLEEP

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 (l) 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 got 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									C M				
	Mon	Work	C											I									C		C	
	Tue	Work							A			I											C			C
	Wed	Work											I											C		
	Thur	Work				C							I										C			
	Fri	Work	C									A	A	A	A		I									
	Sat	Off		C									I													C
	Sun	Off											I										C			
	mon	work	C						A					I									C			
	Tue	work											I										C		C	
	wed	work	C										I													
	Thur	work																								
	Fri	work											A	A	A	A	I									
	Sat	~~work~~ off	C		C			E							I											C
	Sun	off													I											

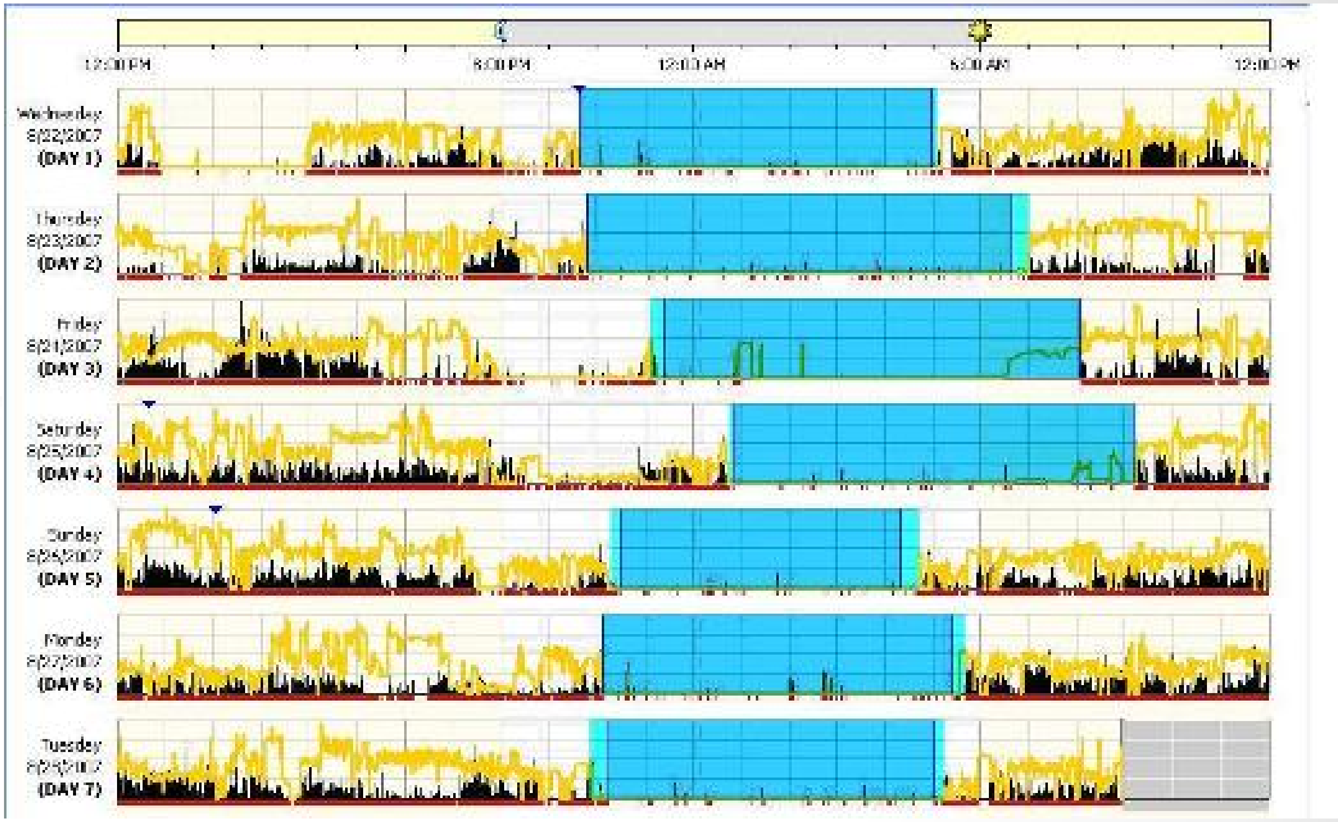
week 1 / week 2

Sleep Diary Version 1 — 25/07/2008

Objective measurement of sleep

- Wrist actigraphy
- Polysomnography (PSG)
  - o Sleep staging and scoring
- Quantitative electroencephalography (EEG)

Wrist actigraphy

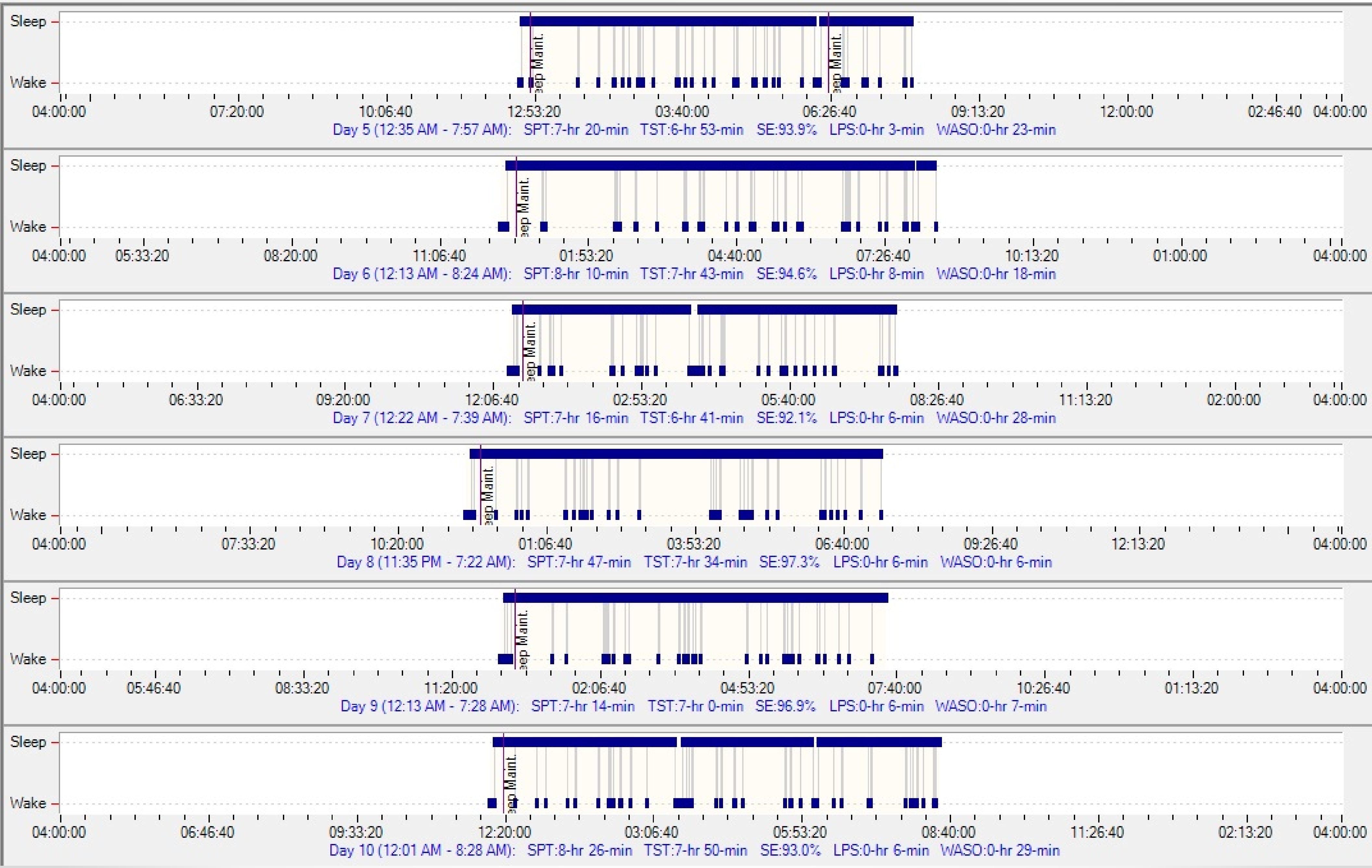


http://mydoctor.kaiserpermanente.org

Portable EEG systems

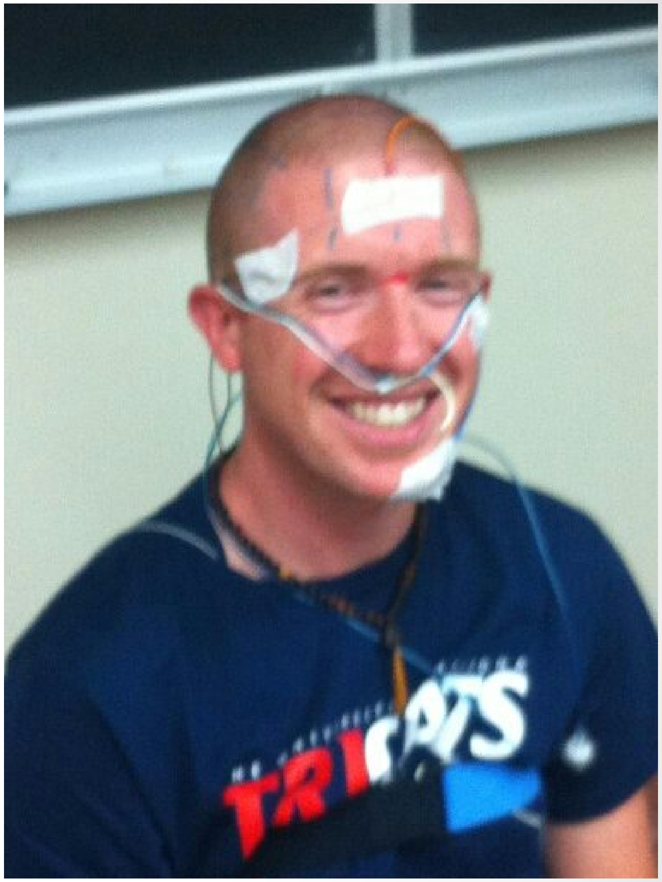
http://www.hanix.net

Zmachine


Sleep
Wake
04:00:00 07:20:00 10:06:40 12:53:20 03:40:00 06:26:40 09:13:20 12:00:00 02:46:40 04:00:00
Day 5 (12:35 AM - 7:57 AM): SPT:7-hr 20-min TST:6-hr 53-min SE:93.9% LPS:0-hr 3-min WASO:0-hr 23-min
04:00:00 05:33:20 08:20:00 11:06:40 01:53:20 04:40:00 07:26:40 10:13:20 01:00:00 04:00:00
Day 6 (12:13 AM - 8:24 AM): SPT:8-hr 10-min TST:7-hr 43-min SE:94.6% LPS:0-hr 8-min WASO:0-hr 18-min
04:00:00 06:33:20 09:20:00 12:06:40 02:53:20 05:40:00 08:26:40 11:13:20 02:00:00 04:00:00
Day 7 (12:22 AM - 7:39 AM): SPT:7-hr 16-min TST:6-hr 41-min SE:92.1% LPS:0-hr 6-min WASO:0-hr 28-min
04:00:00 07:33:20 10:20:00 01:06:40 03:53:20 06:40:00 09:26:40 12:13:20 04:00:00
Day 8 (11:35 PM - 7:22 AM): SPT:7-hr 47-min TST:7-hr 34-min SE:97.3% LPS:0-hr 6-min WASO:0-hr 6-min
04:00:00 05:46:40 08:33:20 11:20:00 02:06:40 04:53:20 07:40:00 10:26:40 01:13:20 04:00:00
Day 9 (12:13 AM - 7:28 AM): SPT:7-hr 14-min TST:7-hr 0-min SE:96.9% LPS:0-hr 6-min WASO:0-hr 7-min
04:00:00 06:46:40 09:33:20 12:20:00 03:06:40 05:53:20 08:40:00 11:26:40 02:13:20 04:00:00
Day 10 (12:01 AM - 8:28 AM): SPT:8-hr 26-min TST:7-hr 50-min SE:93.0% LPS:0-hr 6-min WASO:0-hr 29-min

Sleep Polysomnography (PSG)

- Electroencephalography (EEG)
- Electrooculography (EOG)
- Chin electromyography (EMG)
- Electrocardiography (ECG/EKG)
- Respiration
- Snore mic
- Pulse oximetry
- Leg EMG



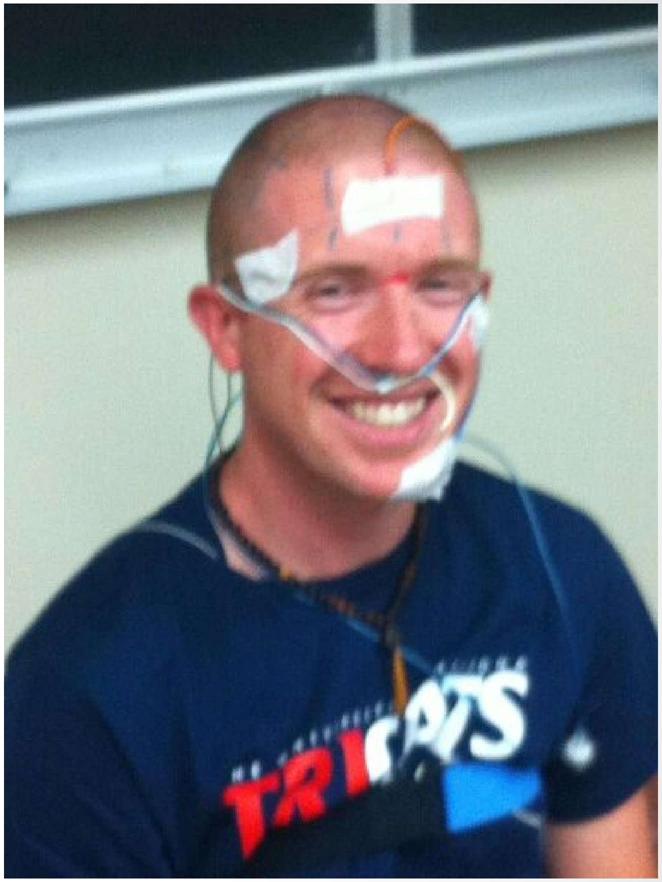
- Subjective staging/scoring process based on 30-second windows

PSG – Types and uses

- Overnight
  - o "Gold-standard" for sleep measurement
  - o Assess and monitor treatment for a variety of sleep disorders (e.g. sleep apnea, period limb movements, narcolepsy)
- Daytime
  - o Provide additional information to help assess specific sleep disorders (e.g. narcolepsy)
  - o Multiple Sleep Latency Test (MSLT)
  - o Maintenance of Wakefulness Test (MWT)

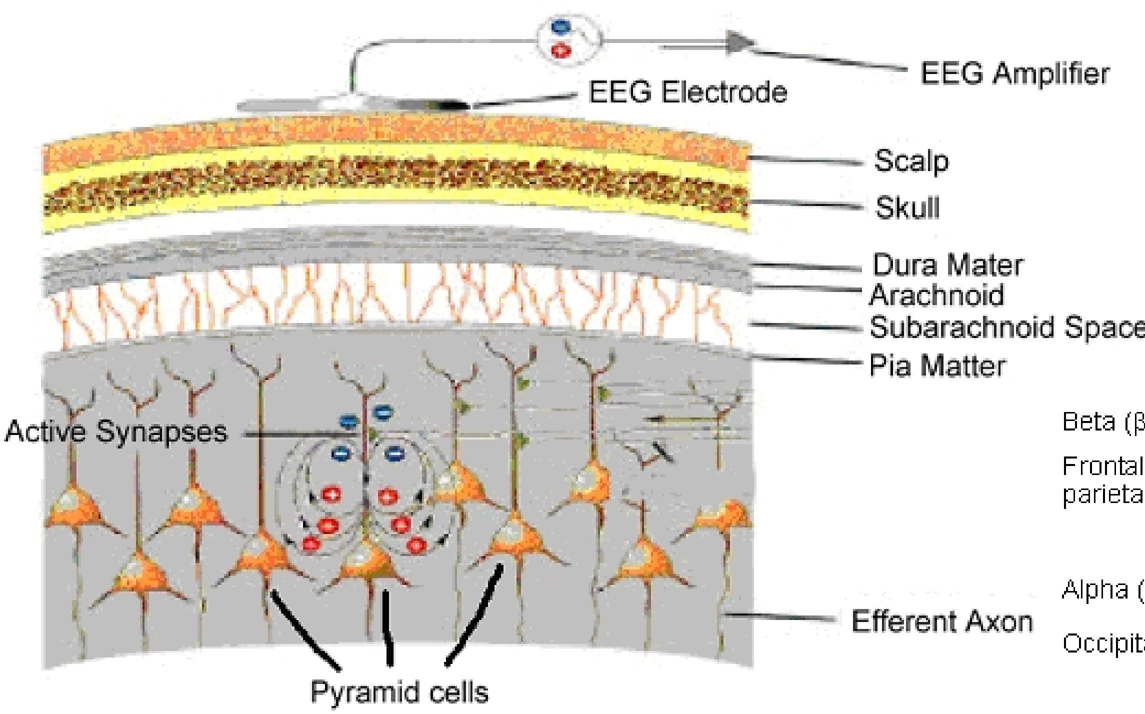
PSG - Components

- **Electroencephalography (EEG)**
- Electrooculography (EOG)
- Chin electromyography (EMG)
- Electrocardiography (ECG/EKG)
- Respiration
- Snore mic
- Pulse oximetry
- Leg EMG

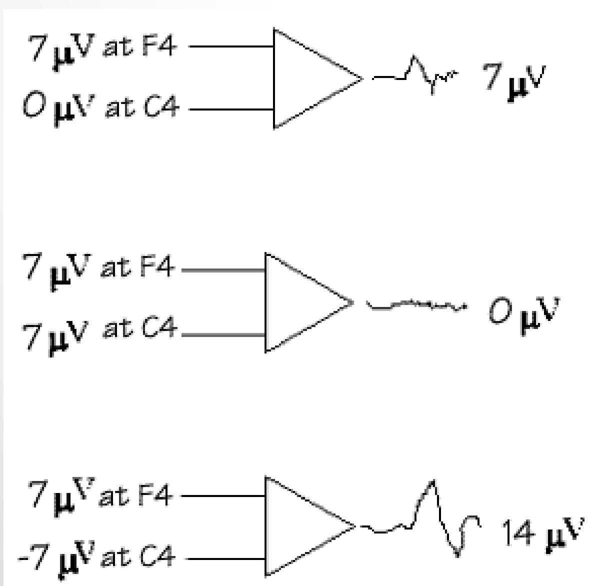


- Subjective staging/scoring process based on 30-second windows

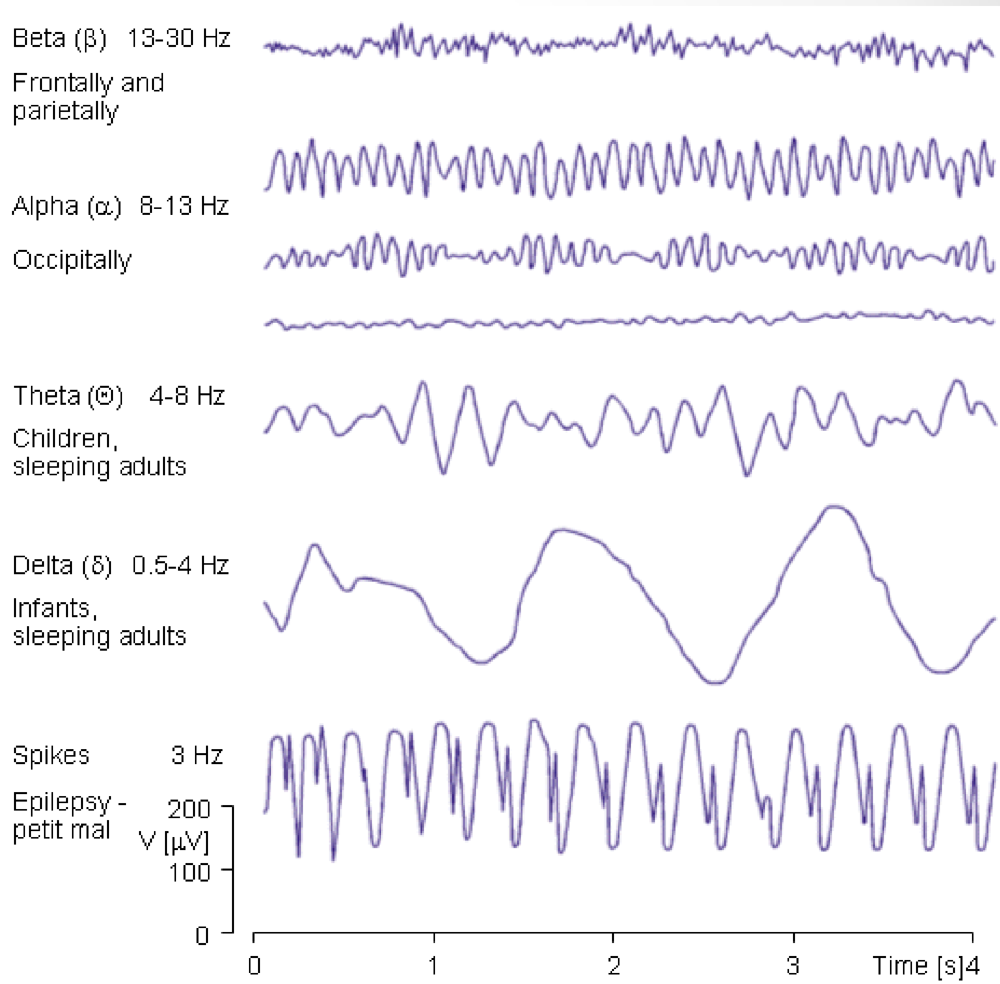
Electroencephalography (EEG)



Bear, Connors & Paradiso (2007). Neuroscience: Exploring the Brain.

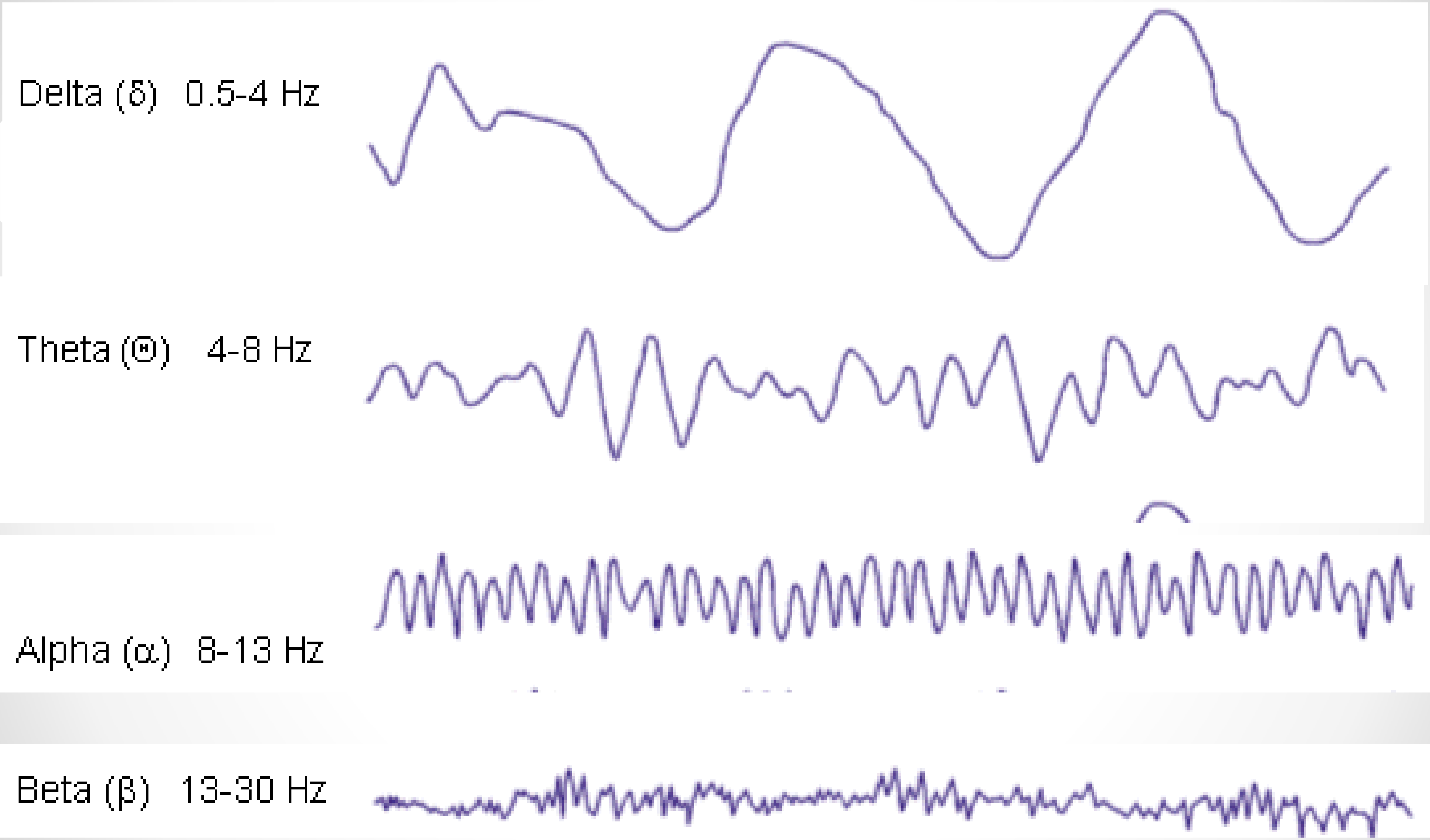


http://www.ebme.co.uk/



Malmivuo & Plonsey (1995). Bioelectromagnetism.

EEG Frequency Bands



Source: American Academy of Sleep Medicine

PSG – Sleep stages

Awake

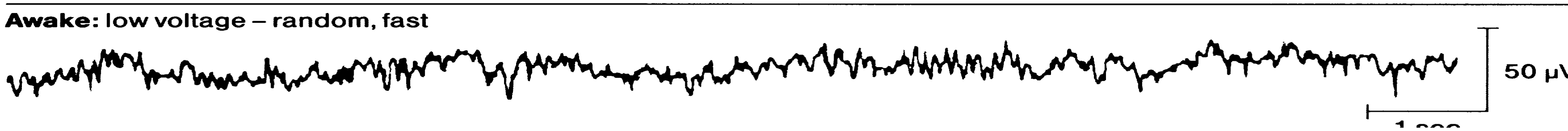
Drowsy

Stage 1

Stage 2

SWS
(formerly3&4)

Stage
REM



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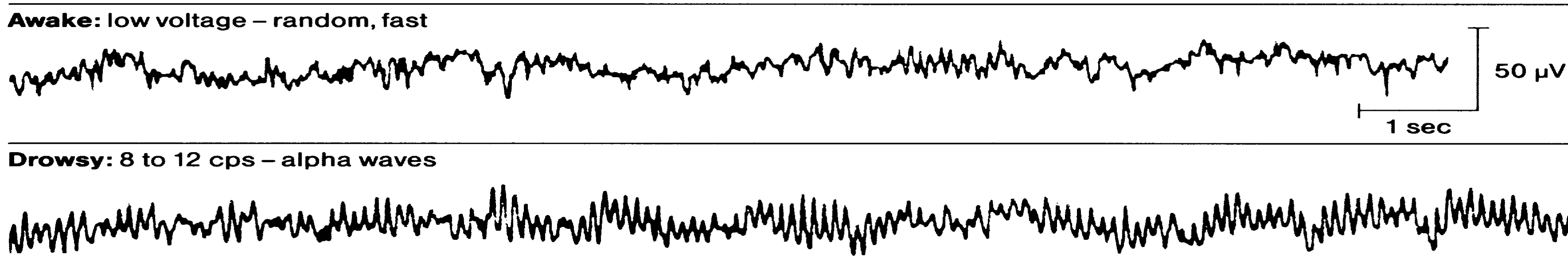

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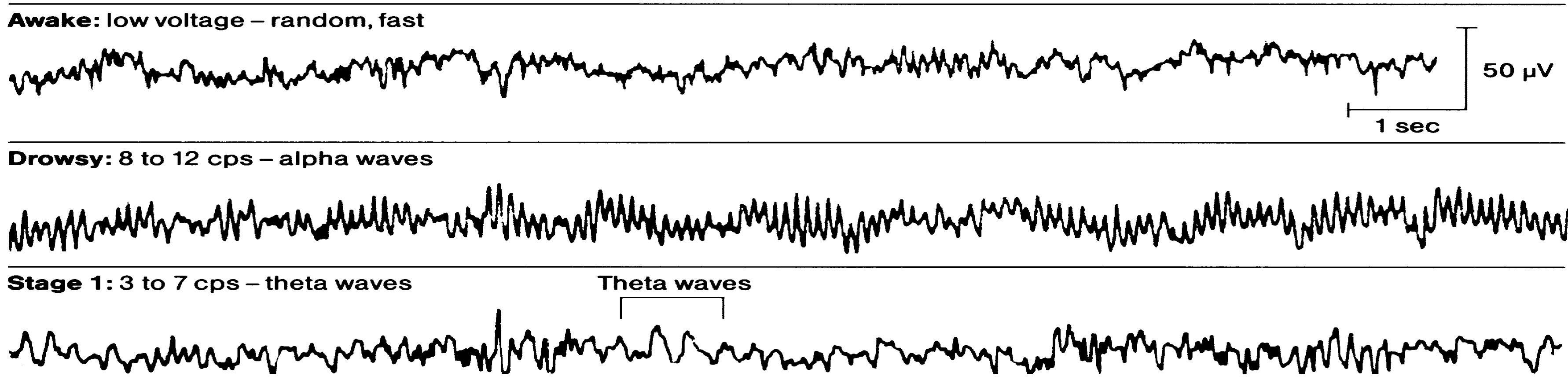

PSG – Sleep stages

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Awake

Drowsy

Stage 1

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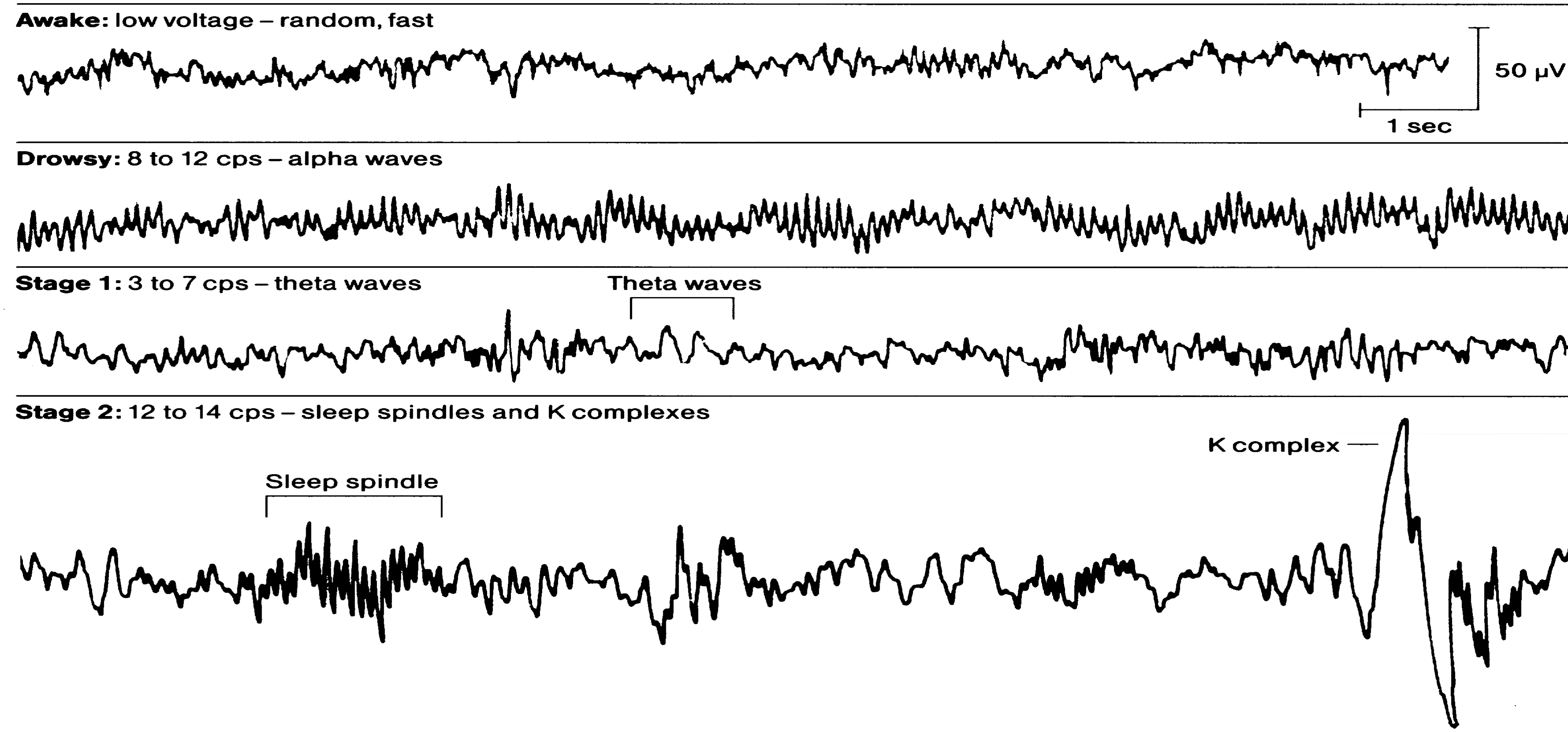

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PSG – Sleep stages

Awake

Drowsy

Stage 1

Stage 2

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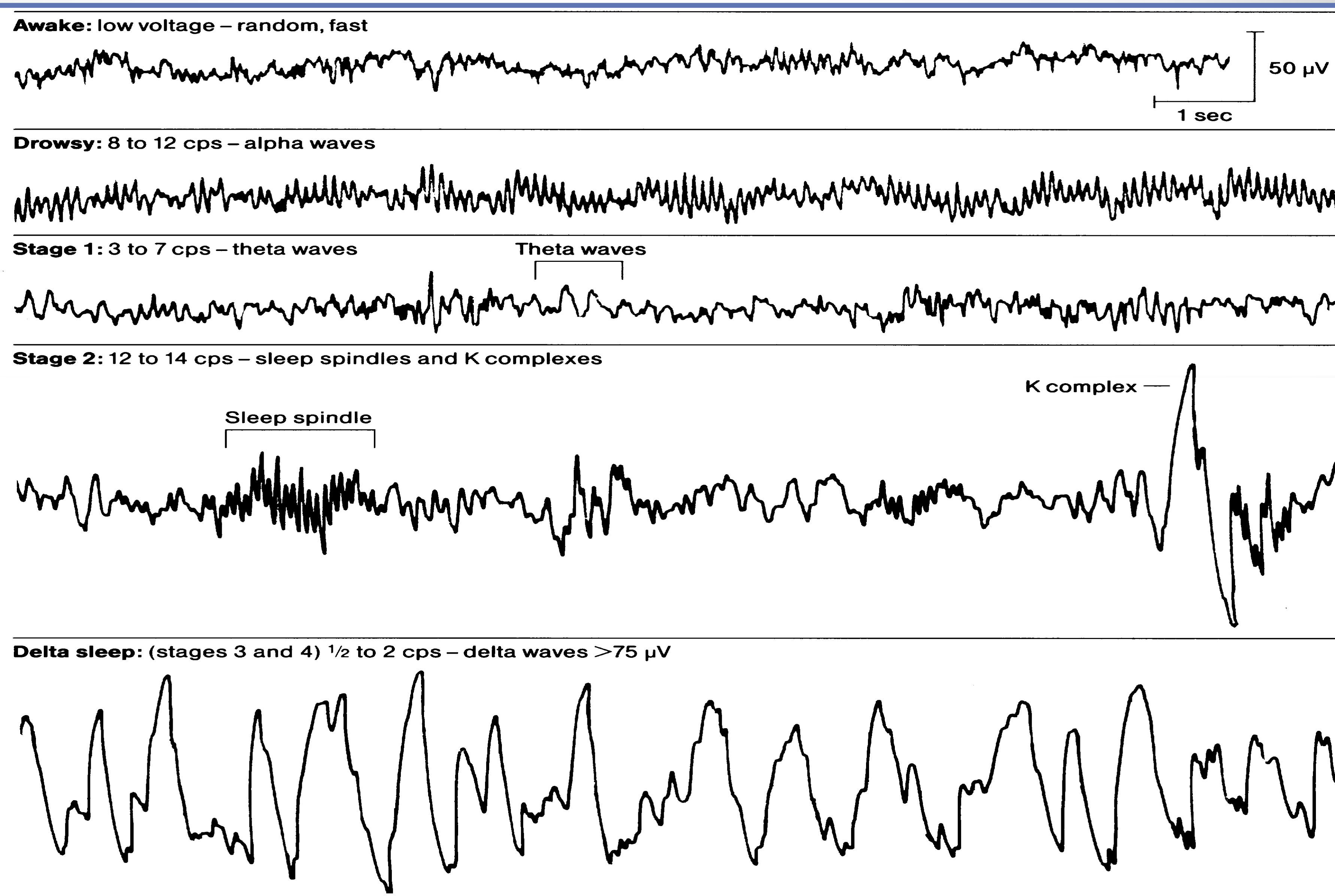
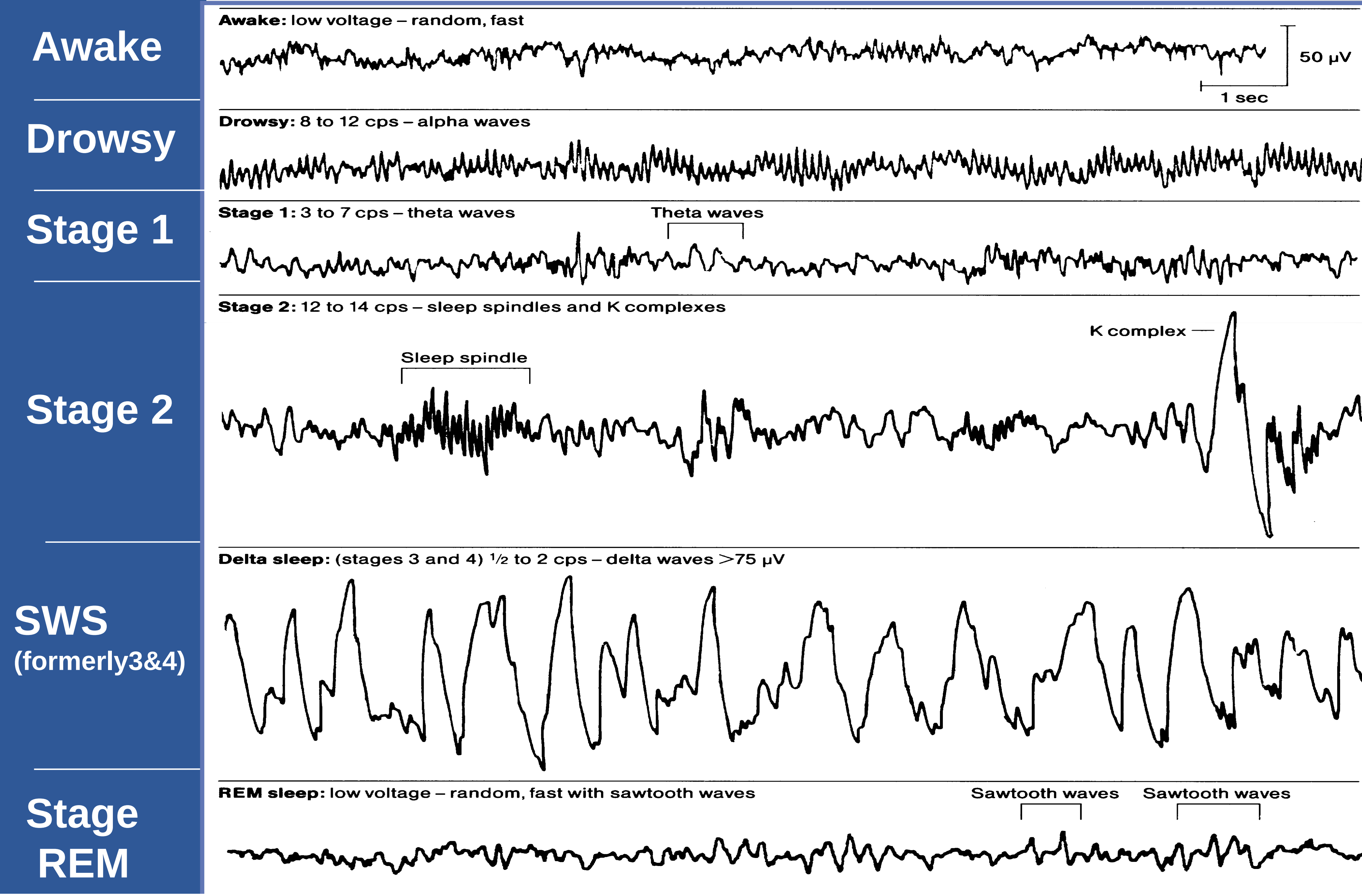
Stage REM



Source: American Academy of Sleep Medicine

PSG – Sleep stages



Source: American Academy of Sleep Medicine

PSG – Sleep stages

Awake

Drowsy

Stage 1

Stage 2

SWS
(formerly3&4)

Stage
REM

- **Wake (Relaxed)**
  - **W:** Alpha EEG (8-12 hz)

Source: American Academy of Sleep Medicine

PSG – Sleep stages

Awake

Drowsy

Stage 1

Stage 2

SWS
(formerly3&4)

Stage
REM

- **Wake (Relaxed)**
  - **W:** Alpha EEG (8-12 hz)

- **NREM Sleep**
  - **N1:** Low voltage, mixed frequency (theta EEG 3-7 hz), slow, rolling eye movements

Source: American Academy of Sleep Medicine

PSG – Sleep stages

Awake

Drowsy

Stage 1

Stage 2

SWS (formerly3&4)

Stage REM

- **Wake (Relaxed)**
  - **W:** Alpha EEG (8-12 hz)

- **NREM Sleep**
  - **N1:** Low voltage, mixed frequency (theta EEG 3-7 hz), slow, rolling eye movements

  - **N2:** Presence of sleep spindles (burst of EEG activity of 12-14 hz lasting at least .5 sec) and K-complexes (large well-defined negative deflection followed by a positive deflection—larger than 75 microvolts)

Source: American Academy of Sleep Medicine

PSG – Sleep stages

Awake

Drowsy

Stage 1

Stage 2

SWS (formerly3&4)

Stage REM

- **Wake (Relaxed)**
  - **W:** Alpha EEG (8-12 hz)
- **NREM Sleep**
  - **N1:** Low voltage, mixed frequency (theta EEG 3-7 hz), slow, rolling eye movements
  - **N2:** Presence of sleep spindles (burst of EEG activity of 12-14 hz lasting at least .5 sec) and K-complexes (large well-defined negative deflection followed by a positive deflection—larger than 75 microvolts)
  - **N3:** Presence for more than 20% of an epoch of delta EEG waves (greater than 75 microvolts and .5-2 hz)

Source: American Academy of Sleep Medicine

PSG – Sleep stages

Awake

- **Wake (Relaxed)**
  - **W:** Alpha EEG (8-12 hz)

Drowsy

Stage 1

- **NREM Sleep**
  - **N1:** Low voltage, mixed frequency (theta EEG 3-7 hz), slow, rolling eye movements

Stage 2

  - **N2:** Presence of sleep spindles (burst of EEG activity of 12-14 hz lasting at least .5 sec) and K-complexes (large well-defined negative deflection followed by a positive deflection—larger than 75 microvolts)

SWS (formerly3&4)

  - **N3:** Presence for more than 20% of an epoch of delta EEG waves (greater than 75 microvolts and .5-2 hz)

Stage REM

- **REM Sleep**
  - **R:** Like N1 (but also has saw-tooth waves), muscle atonia, rapid eye-movements

Where is the change from Stage 2 to Slow Wave Sleep?

The top three tracings are [illegible] high amplitude, slow wave activity but not enough to qualify for Stage 3. The bottom three tracings contain increasing percentages of high amplitude, slow recorded on a Grass Model IV-C electroencephalograph with a paper speed of 15 mm/sec, a time constant of 0.3 sec and a calibration of 50 μV/cm.

[redacted]

Rechtschaffen and Kales, 1968

Sleep Polysomnography (PSG)

- Electroencephalography (EEG)
- Electrooculography (EOG)
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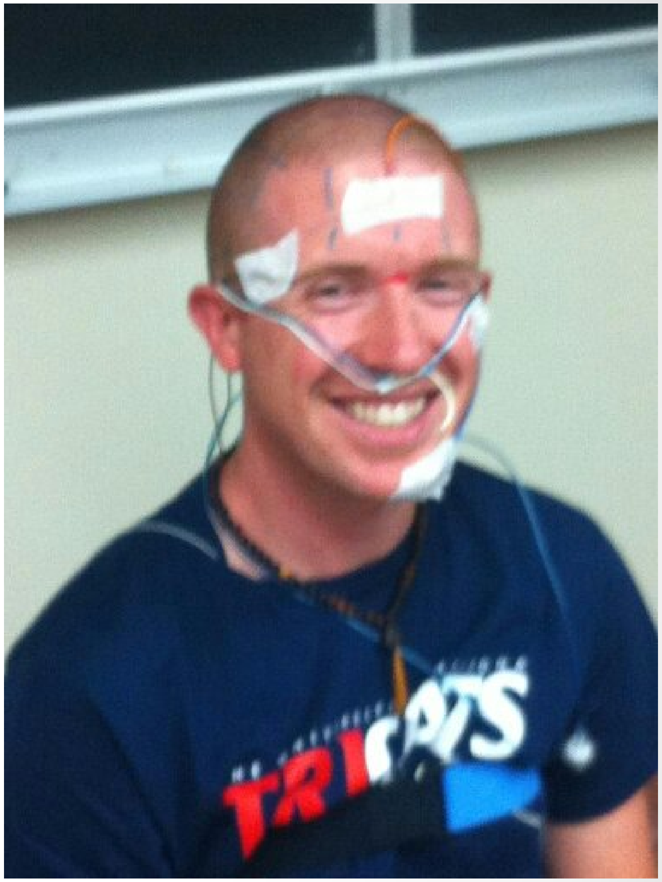
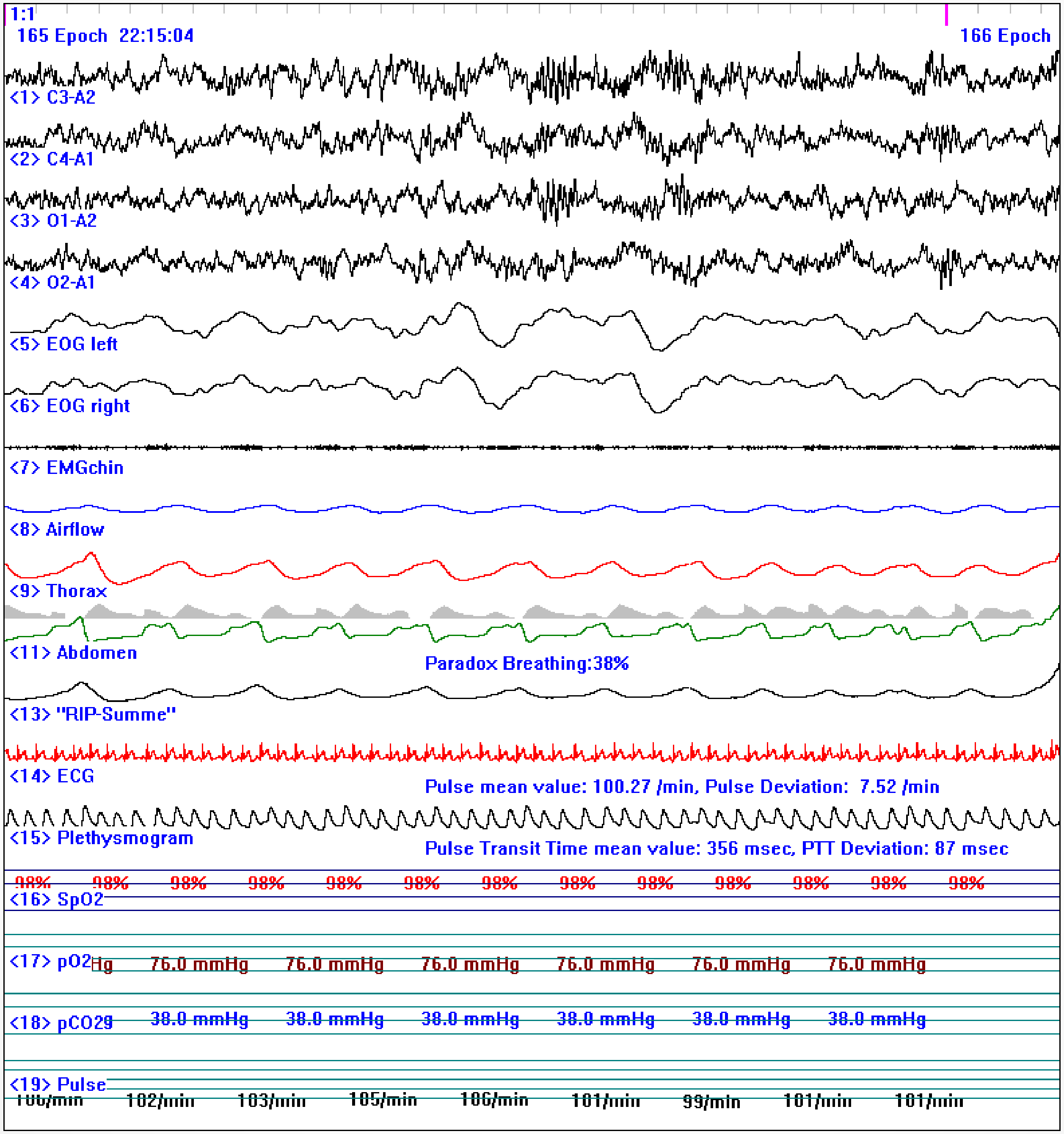
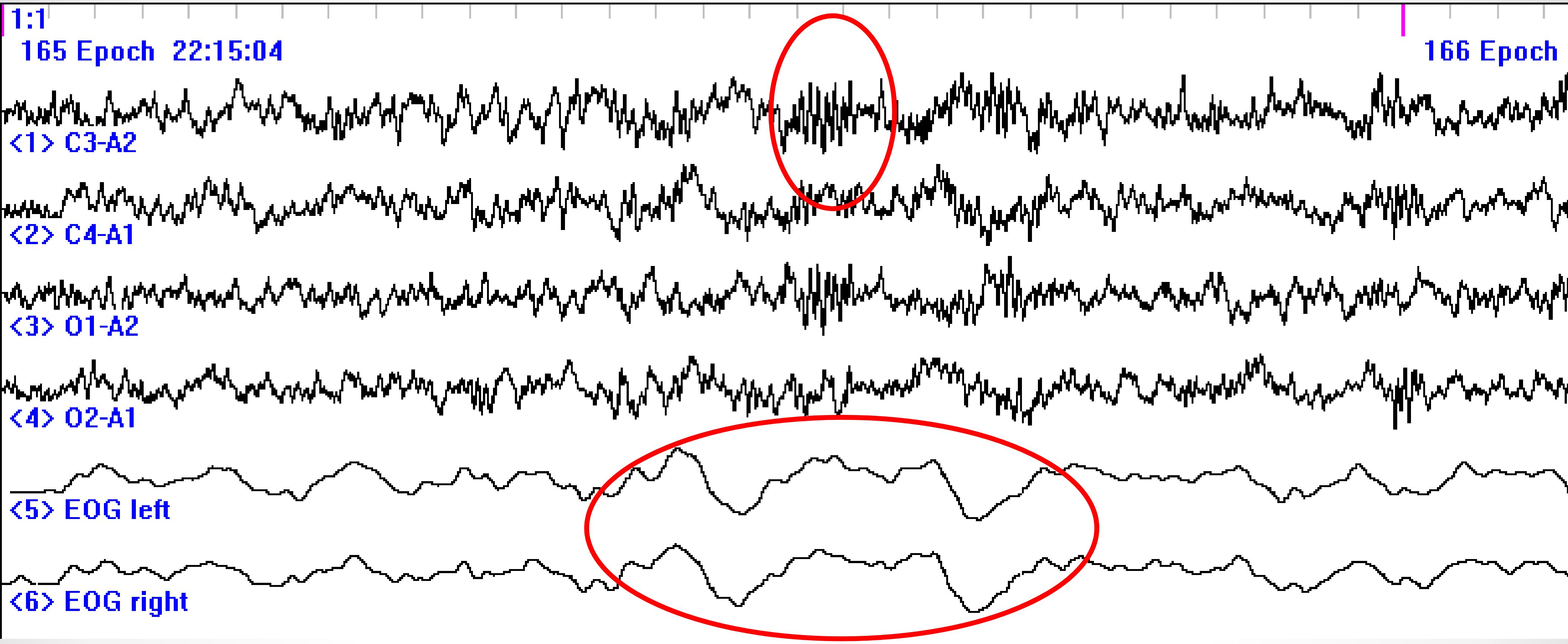


- Subjective staging/scoring process based on 30-second windows

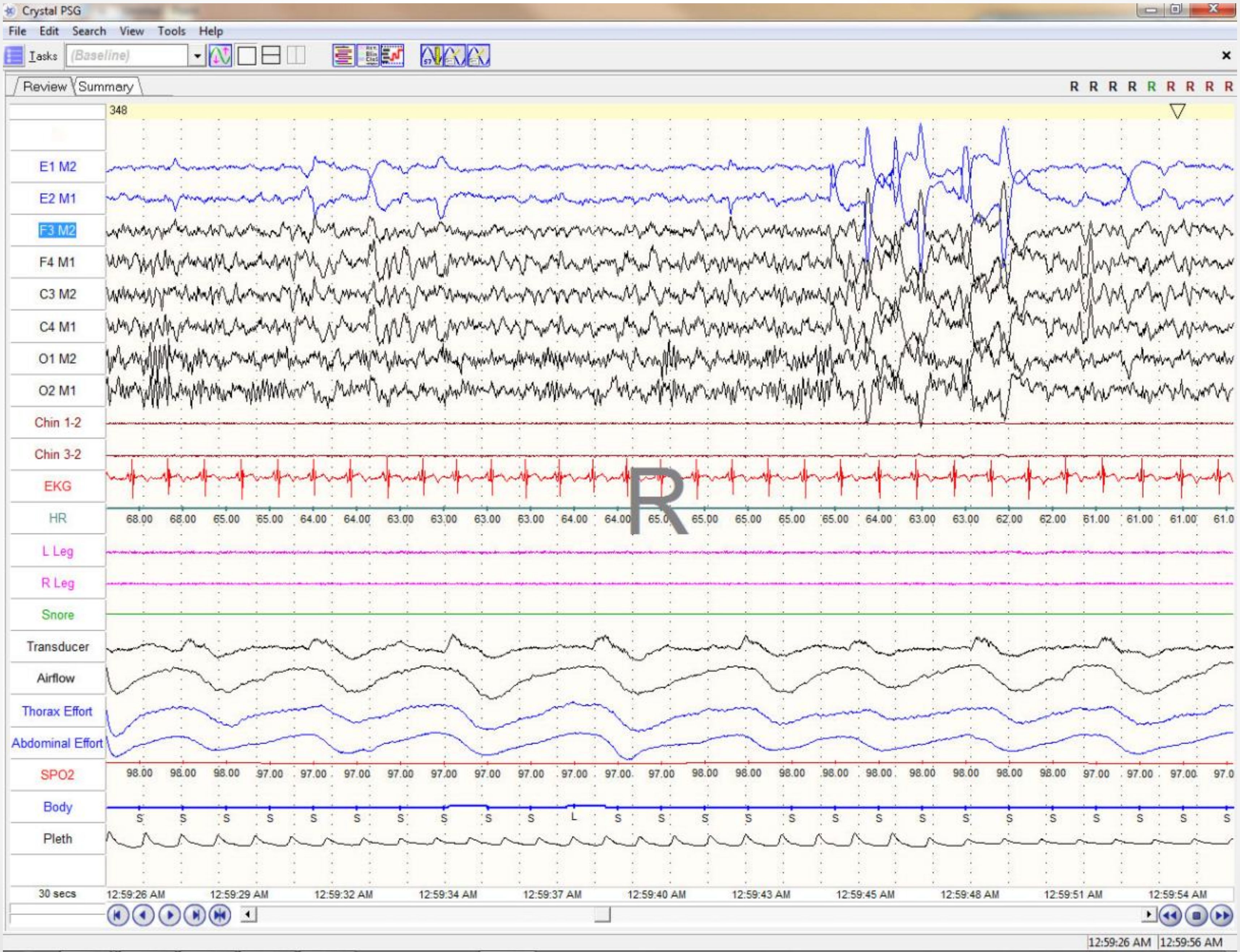
PSG recording example – NREM sleep



PSG recording example – NREM sleep

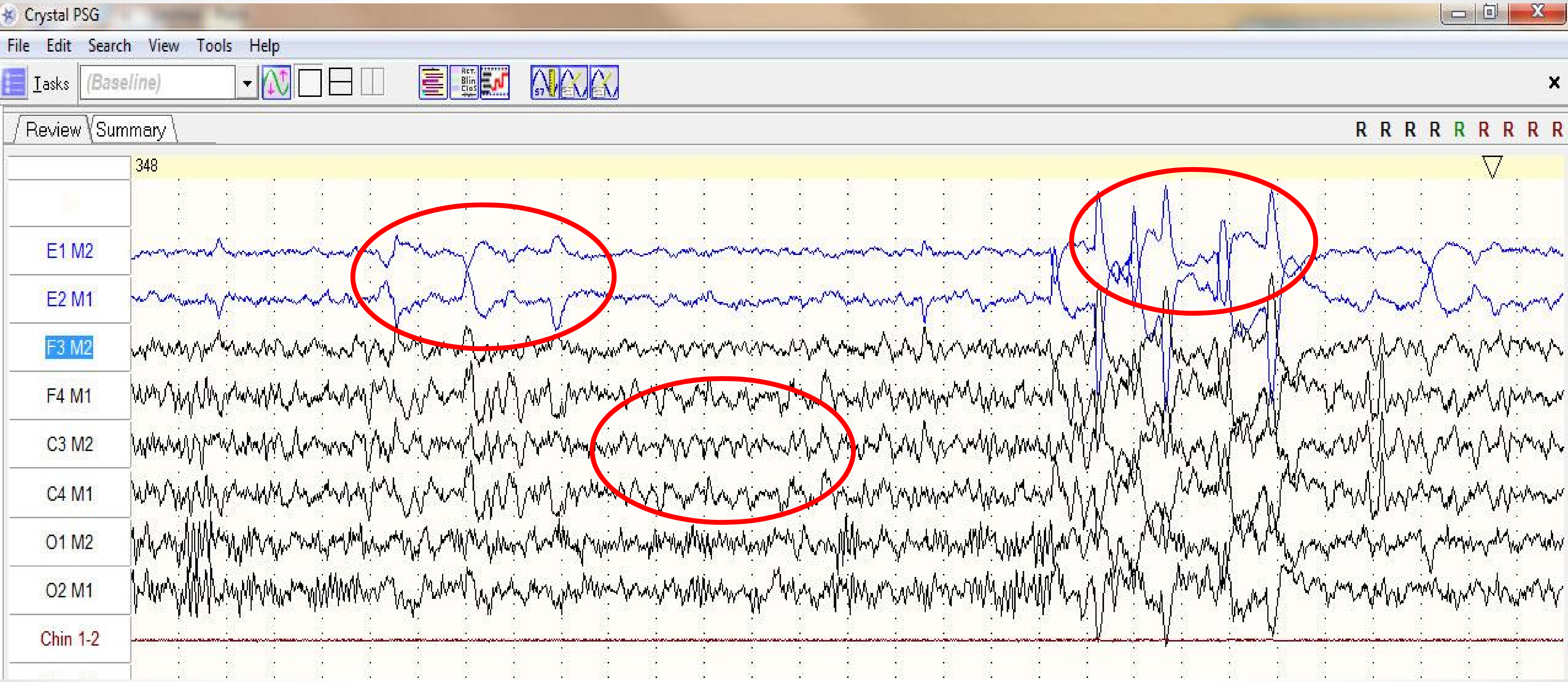


PSG recording example – REM sleep



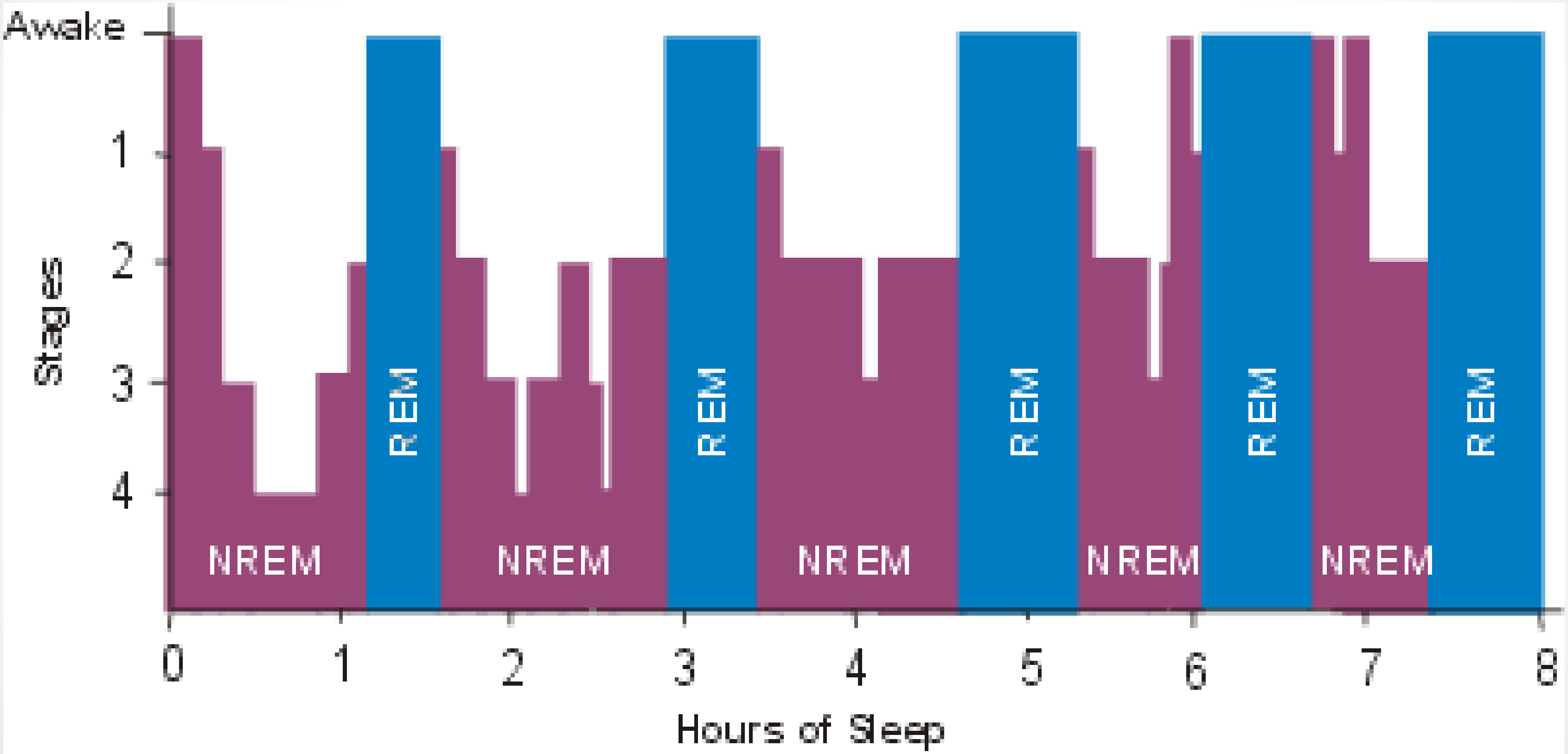
http://clevemed.com/

PSG recording example – REM sleep



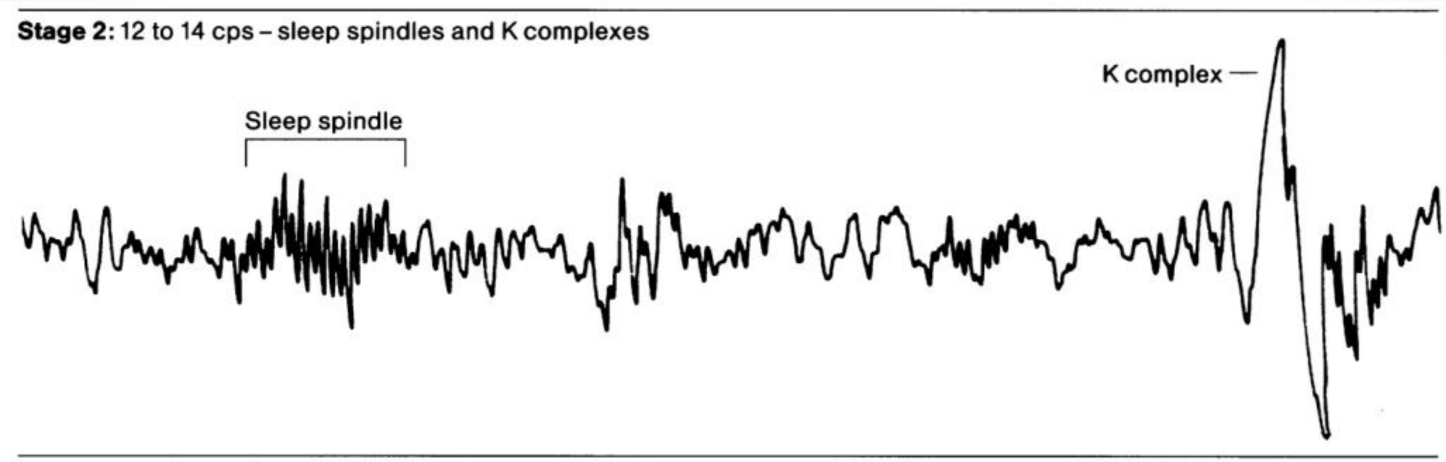
http://clevemed.com/

Hypnogram of healthy sleep



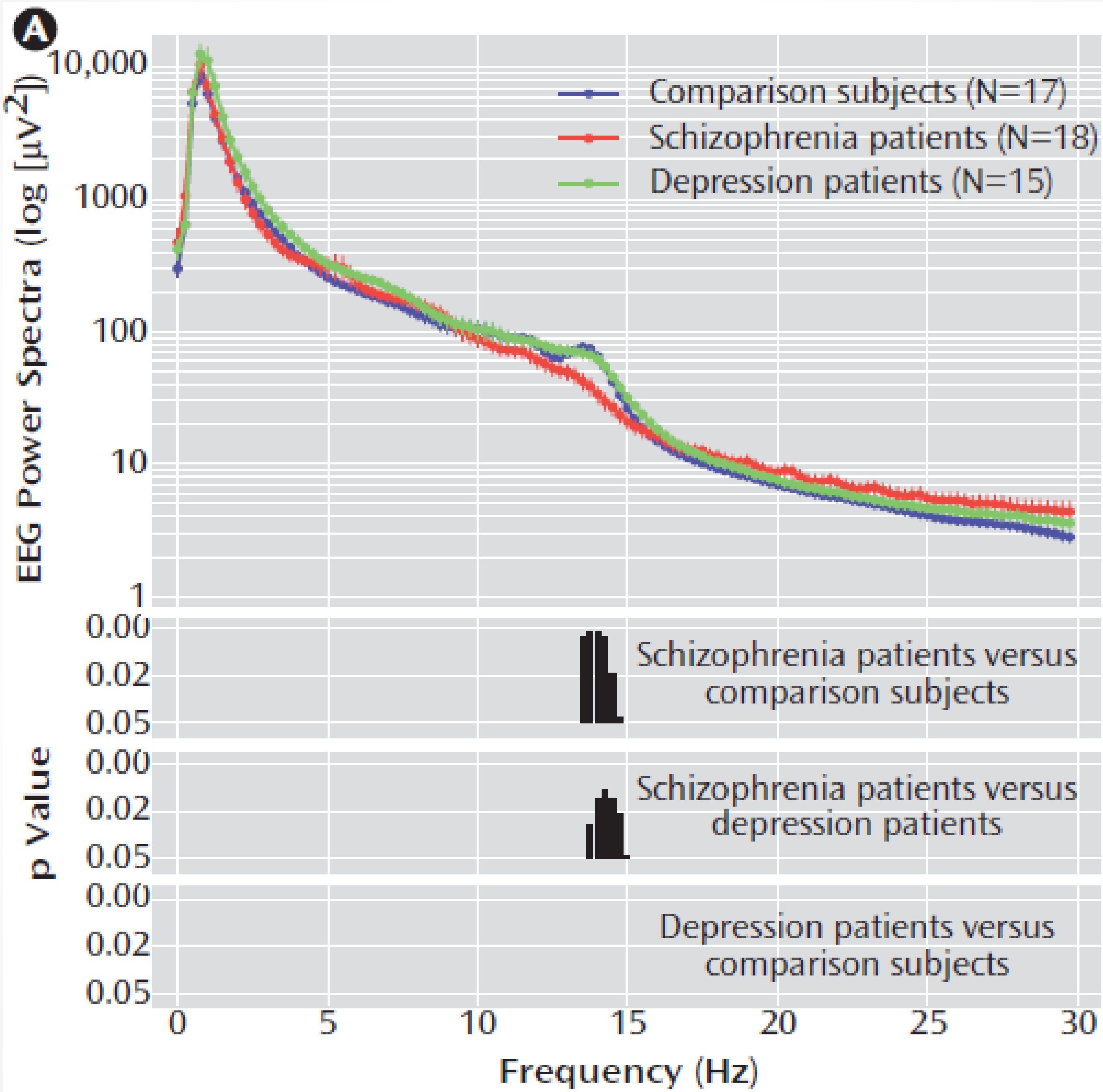
Sequences of states and stages of sleep on a typical night

Quantitative EEG for sleep research



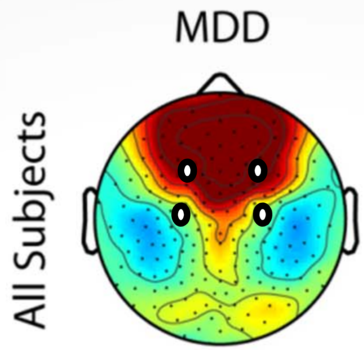
- Spectral analysis (frequency domain)
- Other qEEG techniques

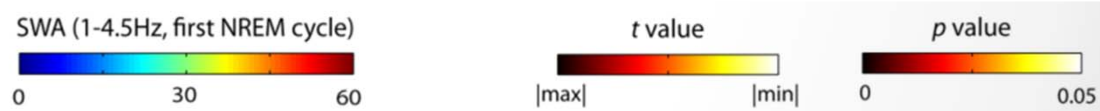
Power Spectra



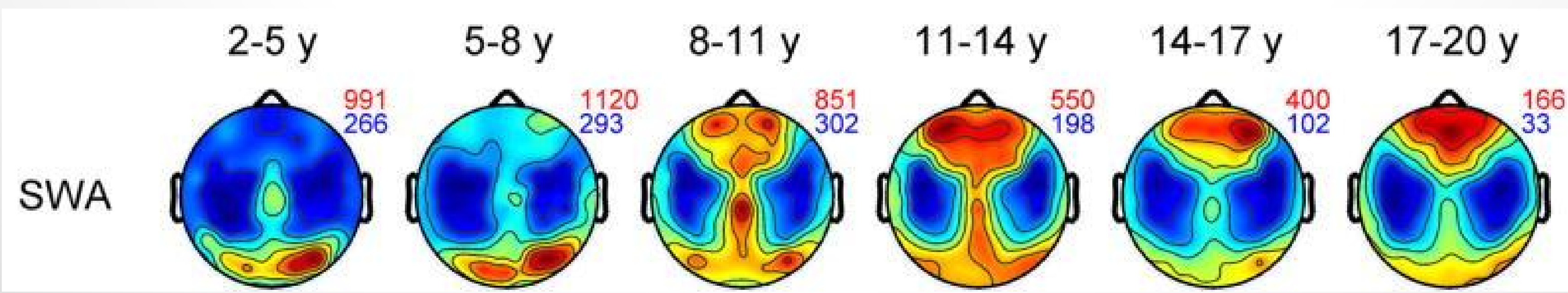
Ferrarelli et al. (2007)

Topography



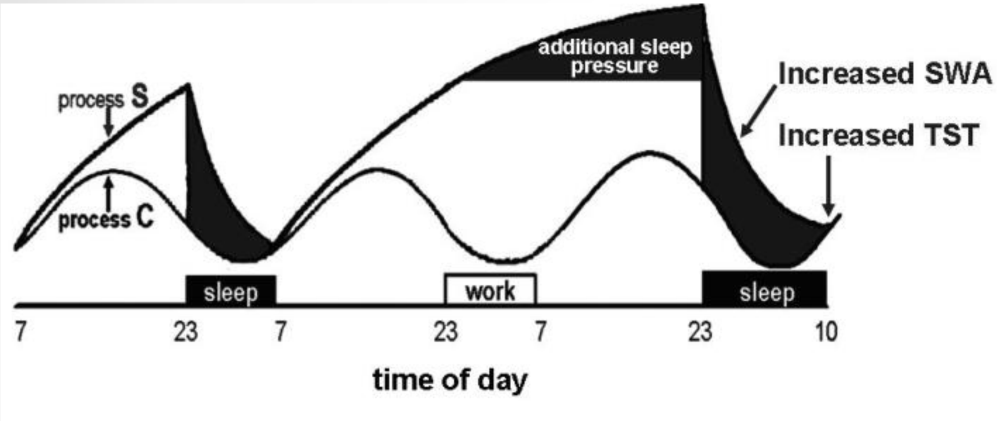


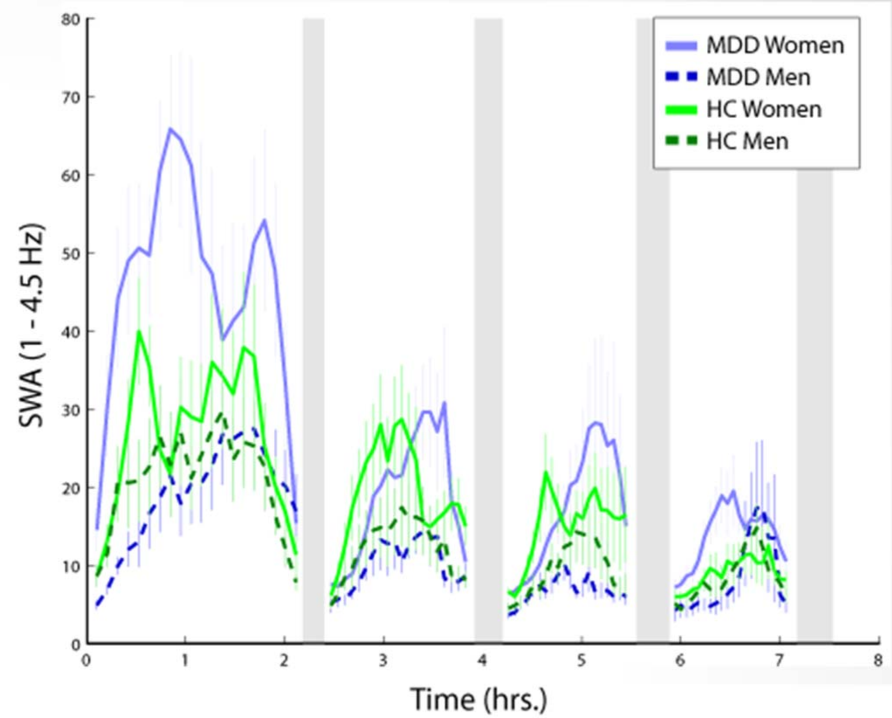
Plante et al. (2012)

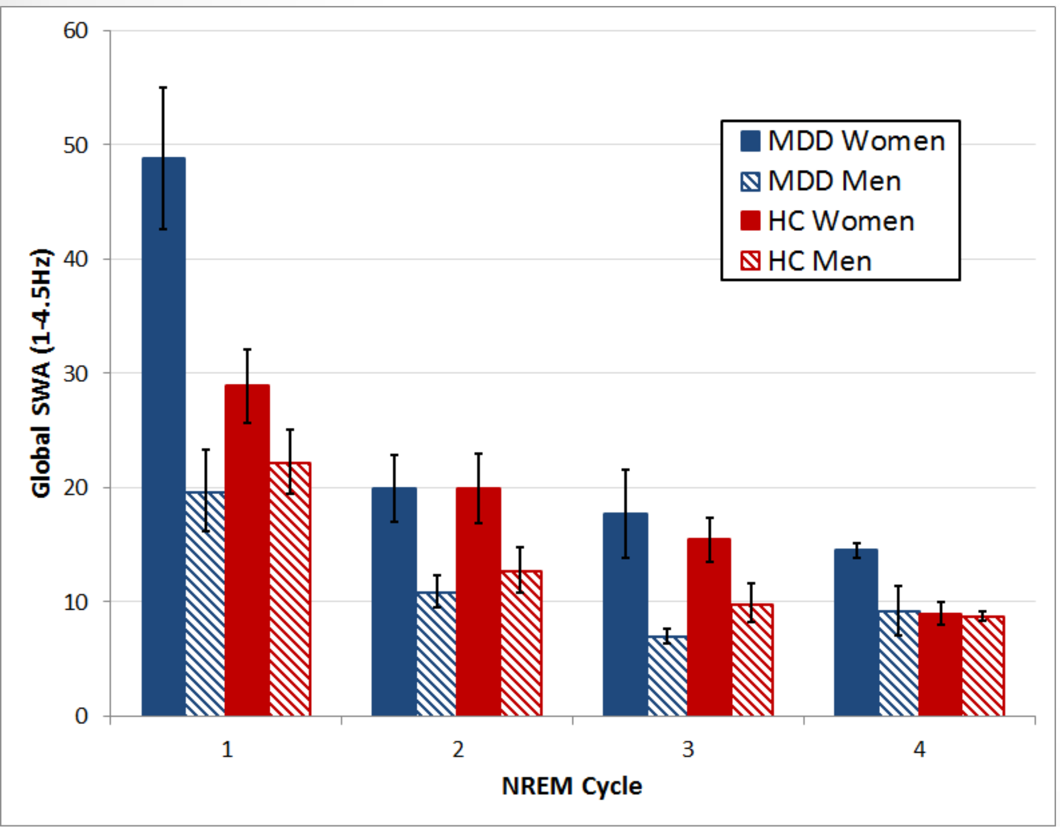


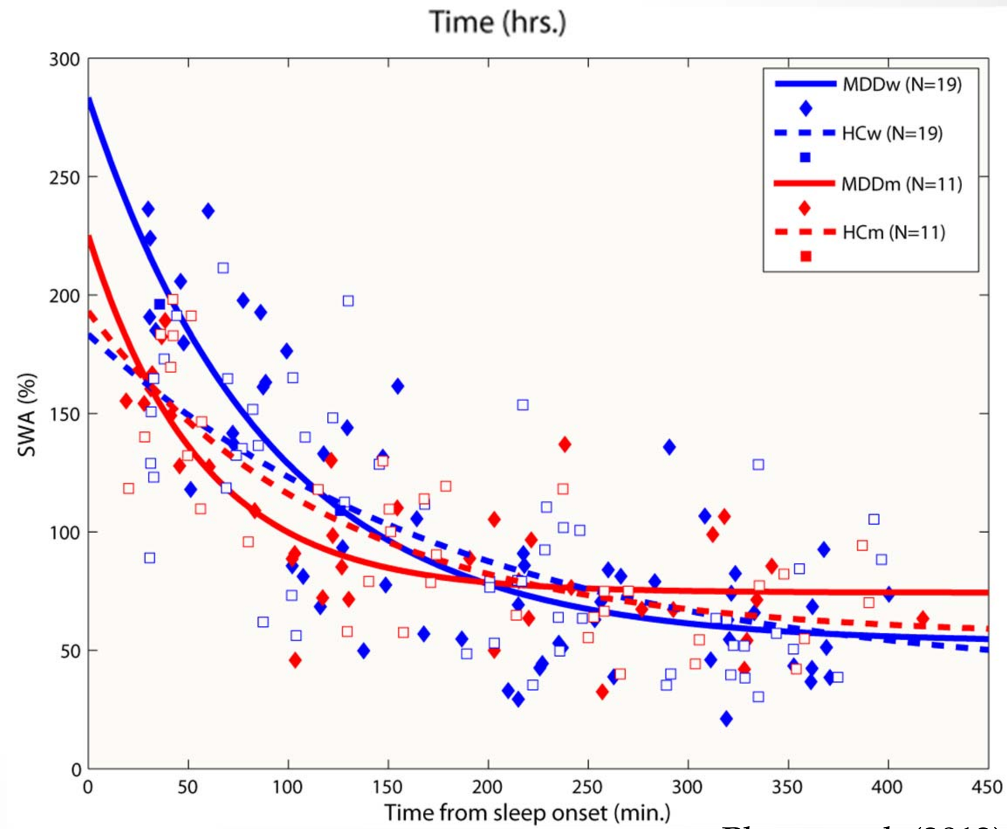
Kurth et al. (2010)

Timecourse



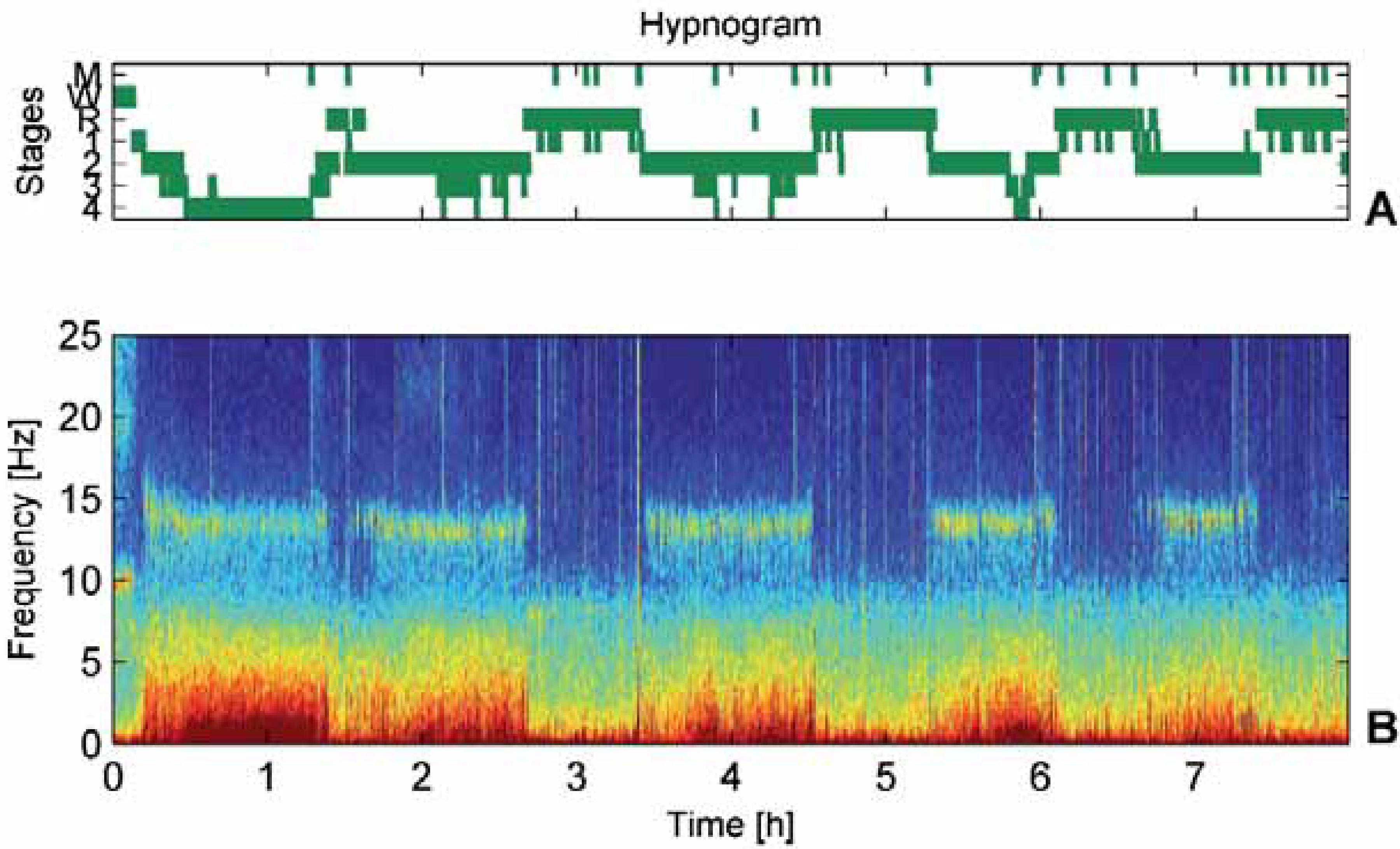






Plante et al. (2012)

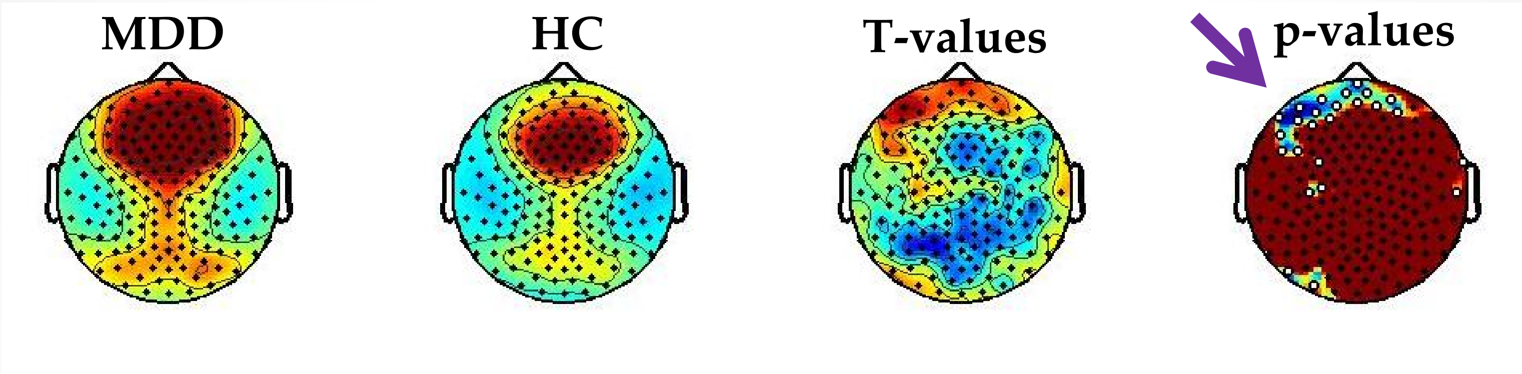
Time-frequency plots

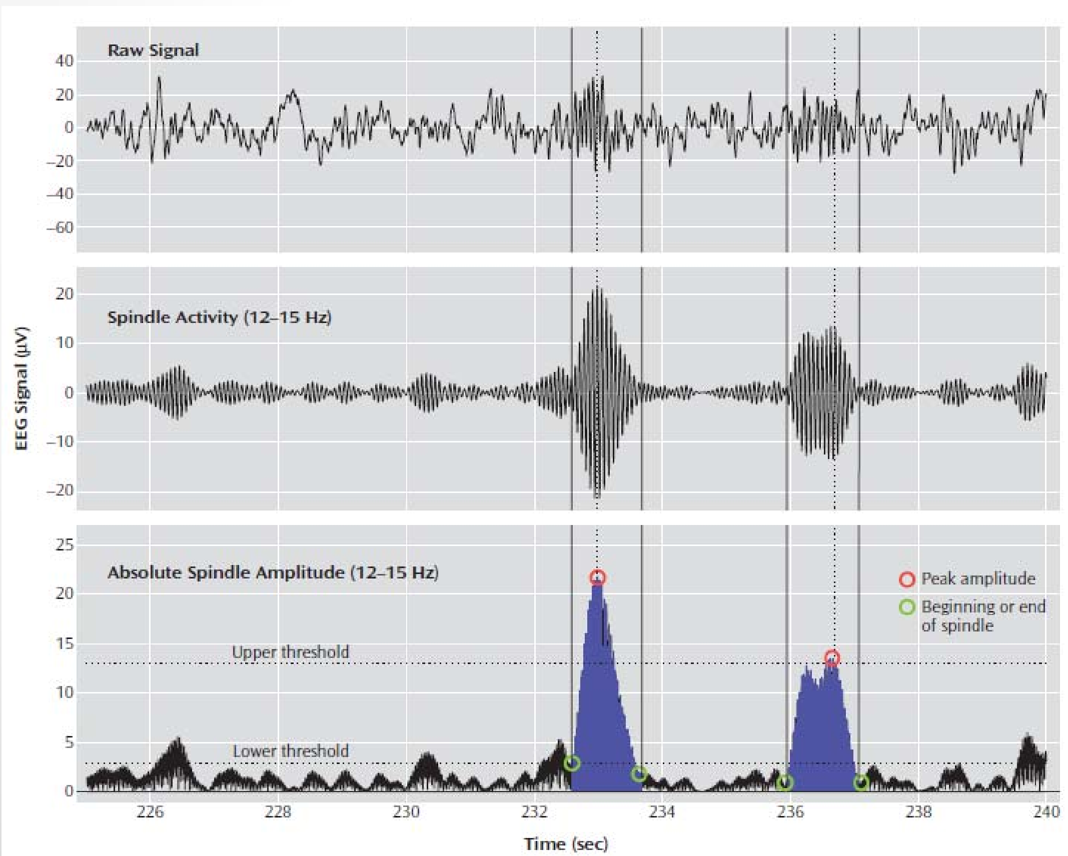


Achermann et al. (2009)

Waveform detection

Spindle Activity (11-13Hz)





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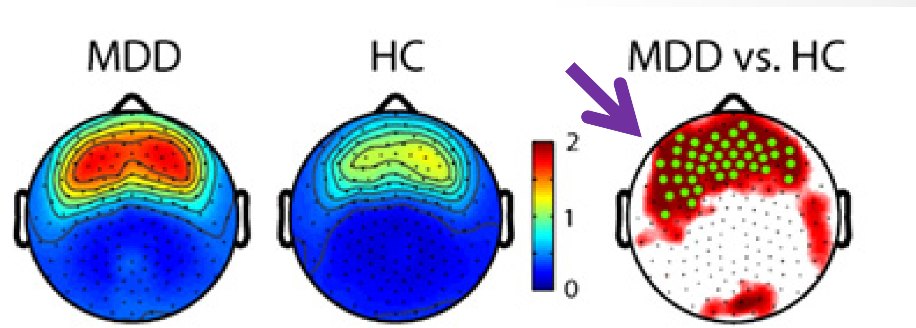
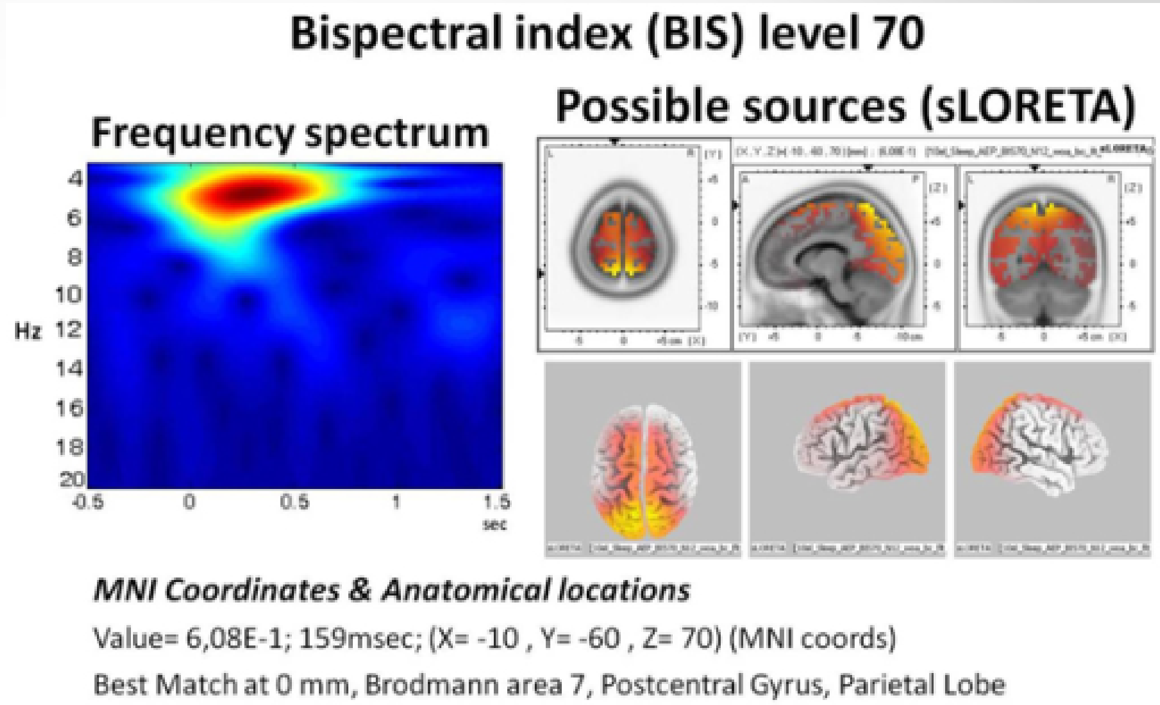
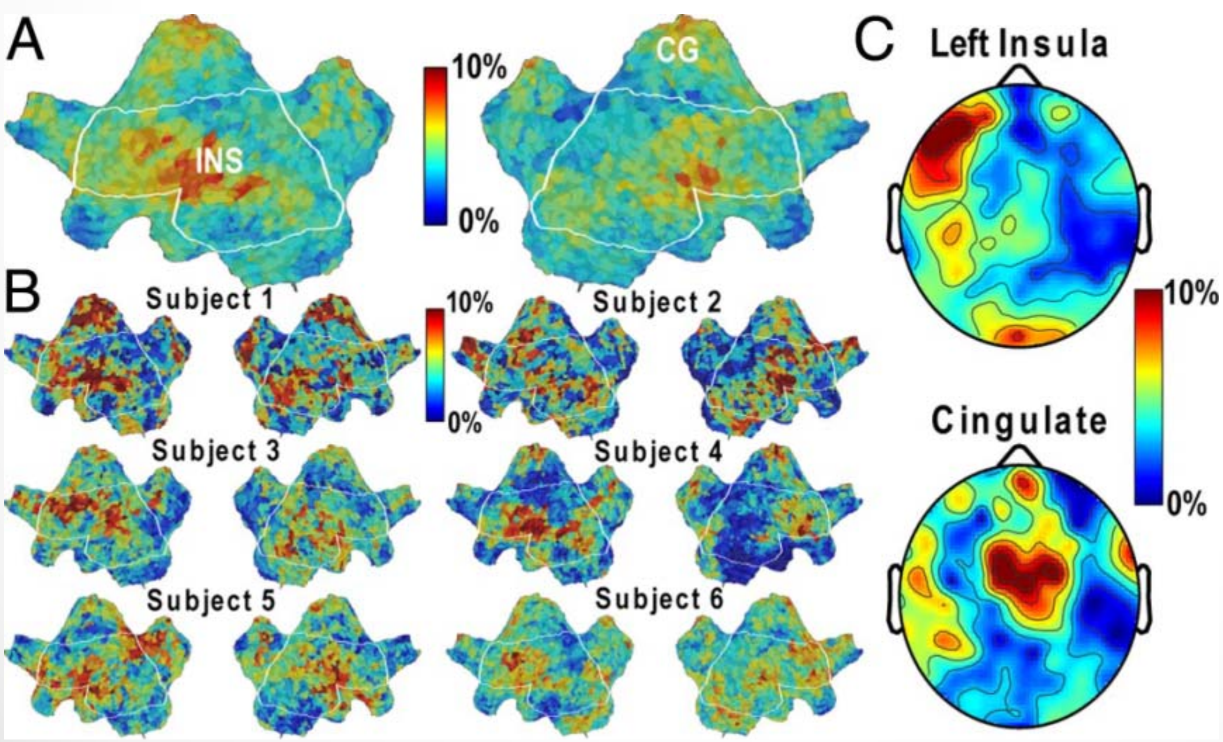


Plante et al. (2012)

Source localization

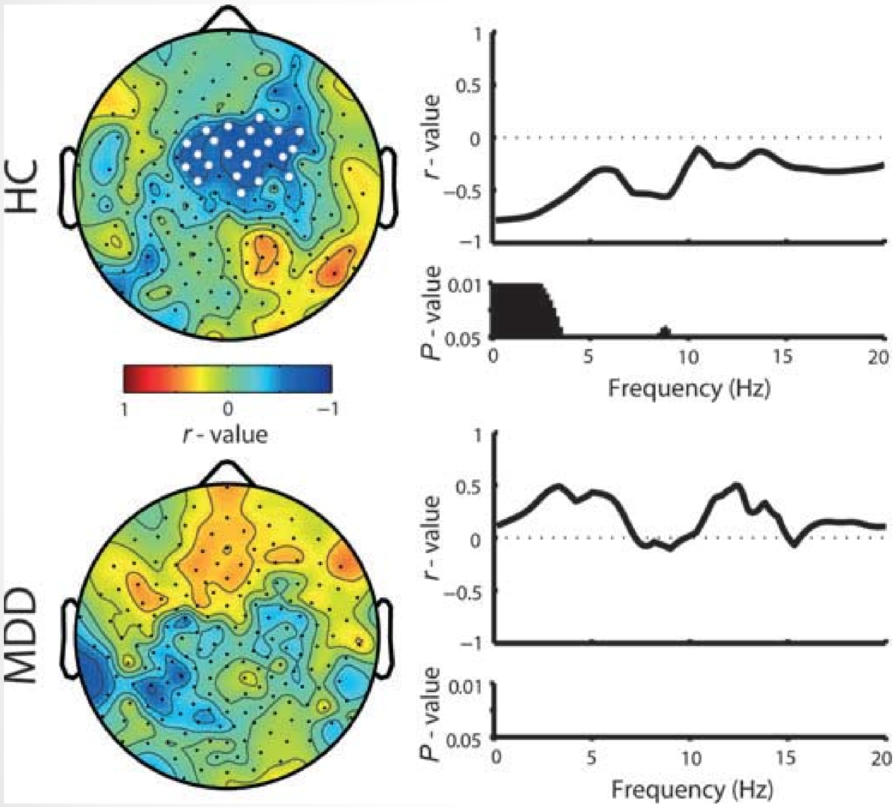


Ozgoren et al. (2010)

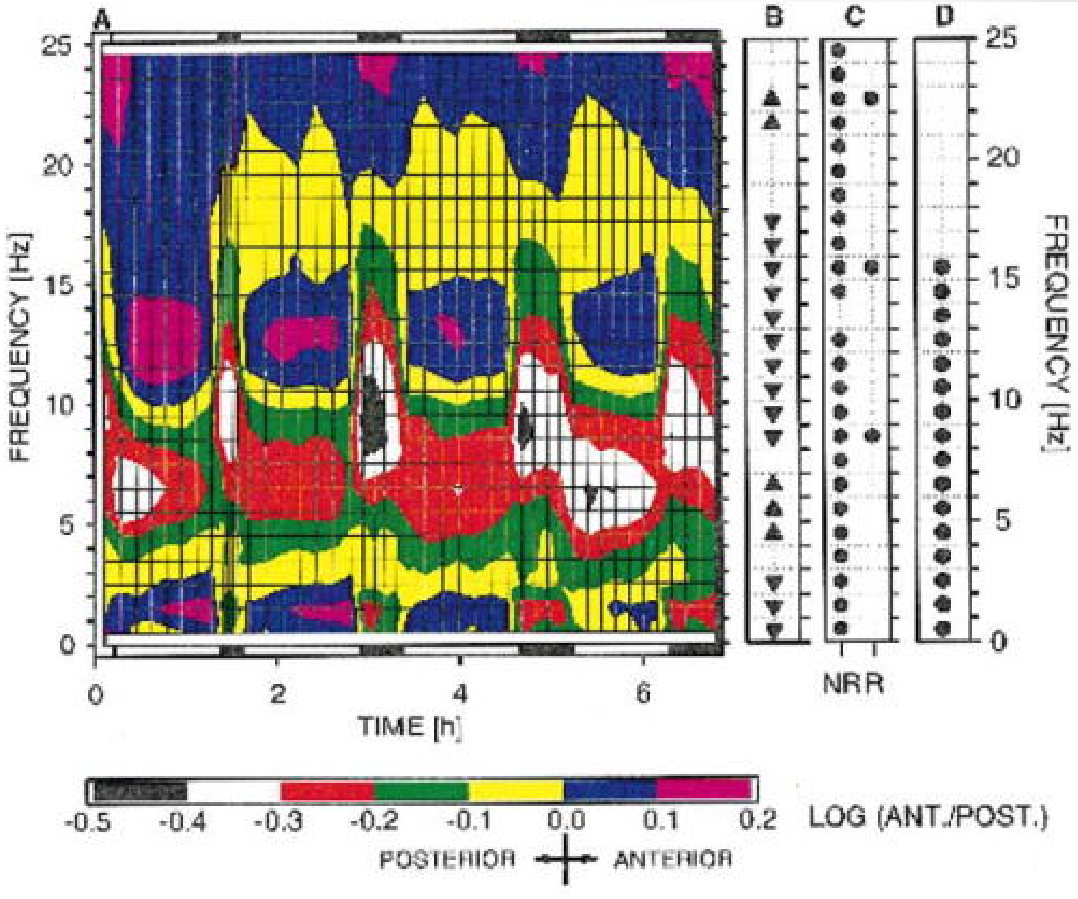


Murphy et al. (2009)

Many more (creative) options



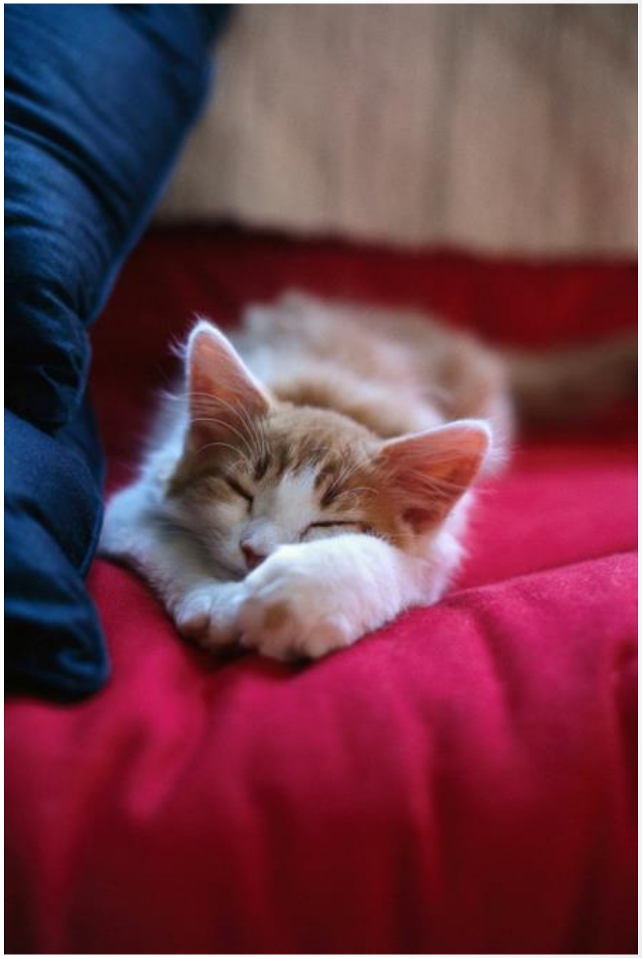
Goldstein et al. (2012)

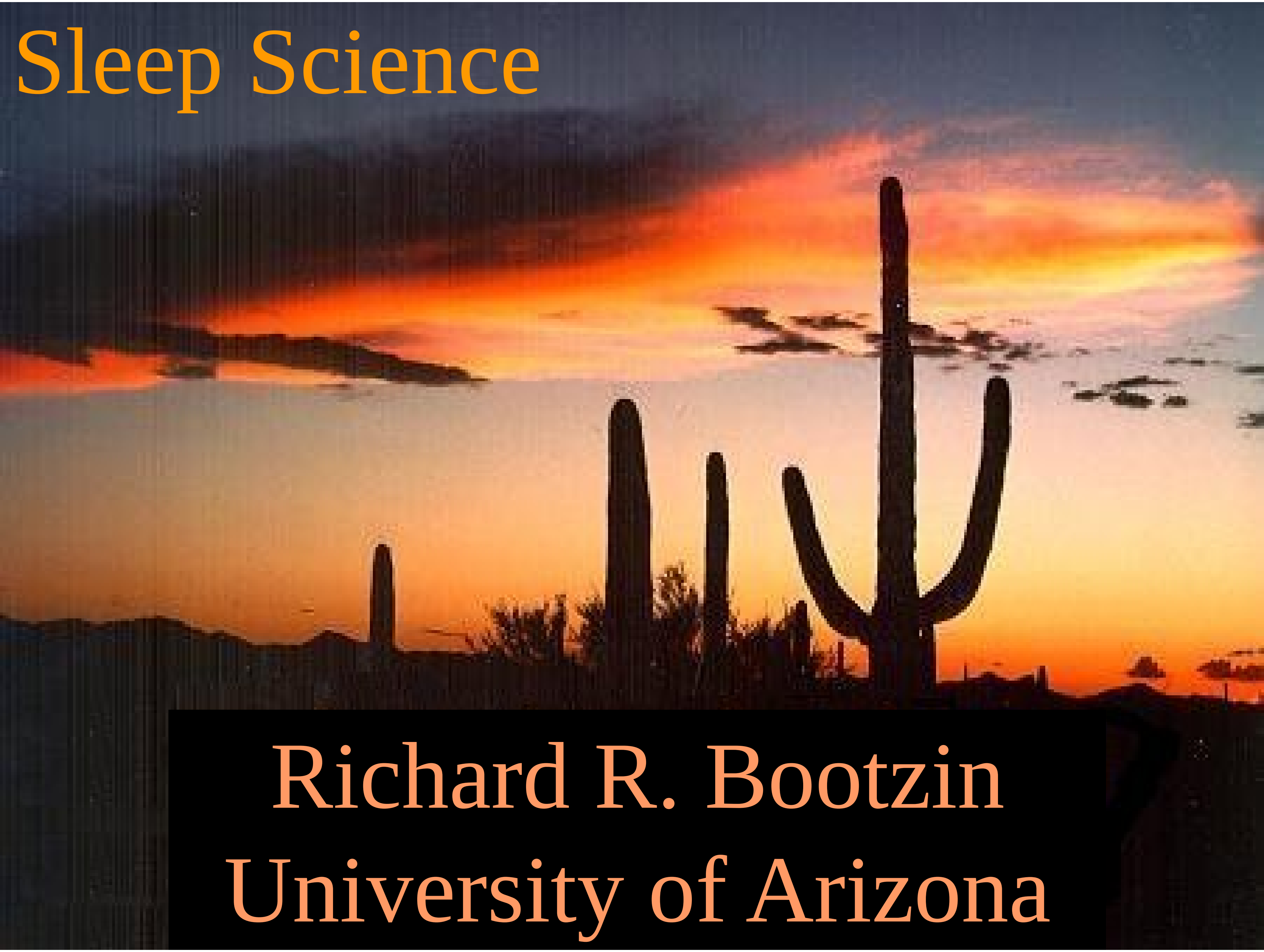


Werth, Achermann & Borbely (1996)

Review

- Defining sleep
  - Behavioral characteristics
  - Physiological characteristics
  - Homeostatic features
  - Circadian features
- Subjective measures
  - Retrospective ratings
  - Sleep diary
- Objective measures
  - Wrist actigraphy
  - Portable EEG
  - Polysomnography (PSG)
  - Quantitative EEG for research

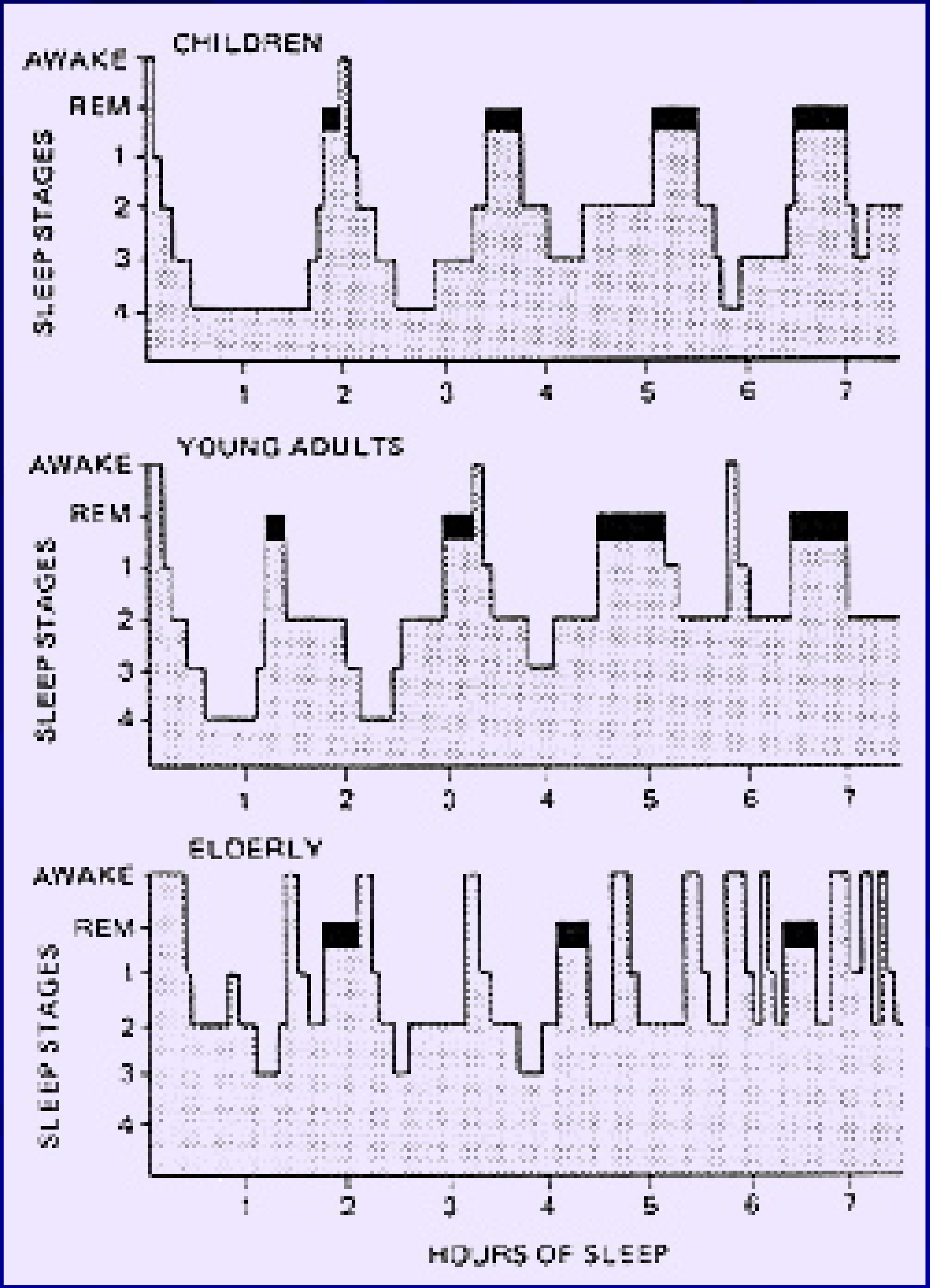




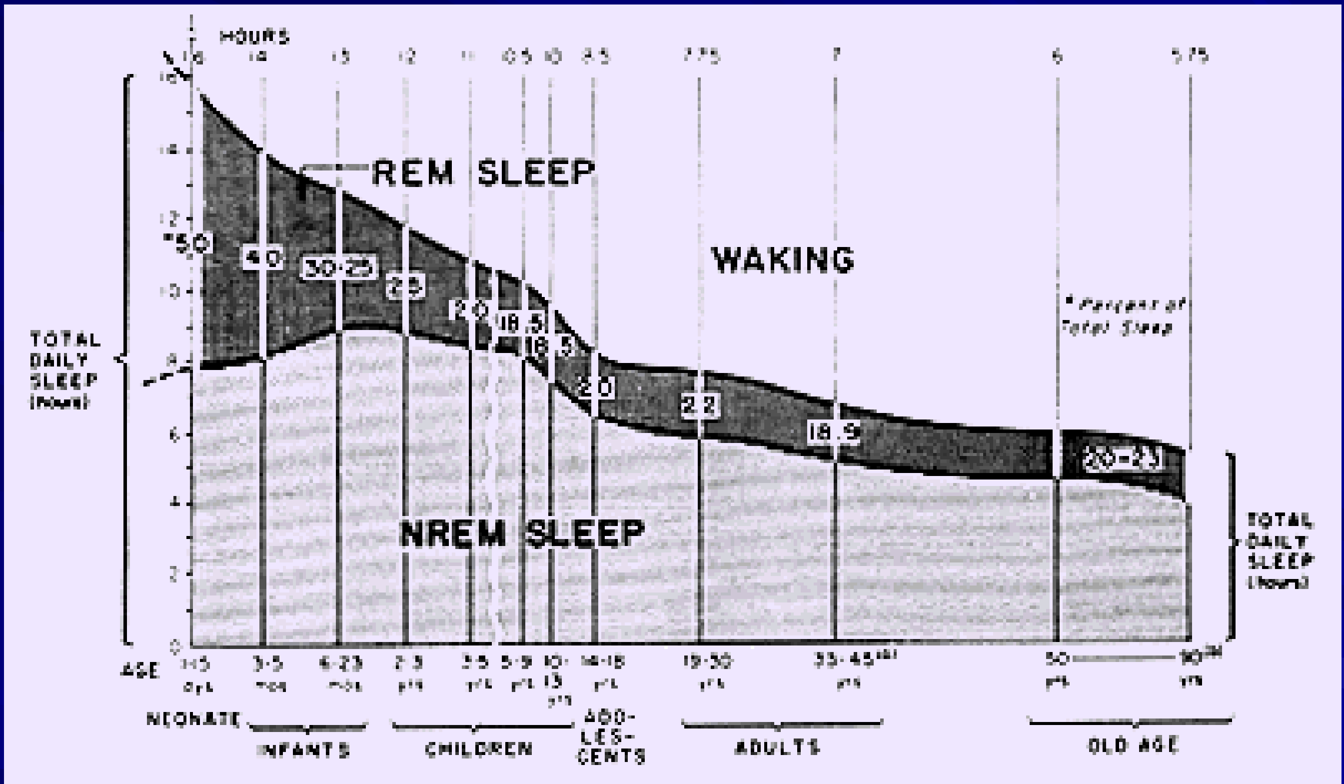
Sleep Science

Richard R. Bootzin
University of Arizona

Hypnograms from polysomnography (all-night sleep studies)



Developmental Changes in Sleep



Biological Rhythms

Circadian: About a day

Ultradian: Shorter than a day; e.g. 90 minute cycles

Infradian: Longer than a day; e.g., menstrual and seasonal cycles

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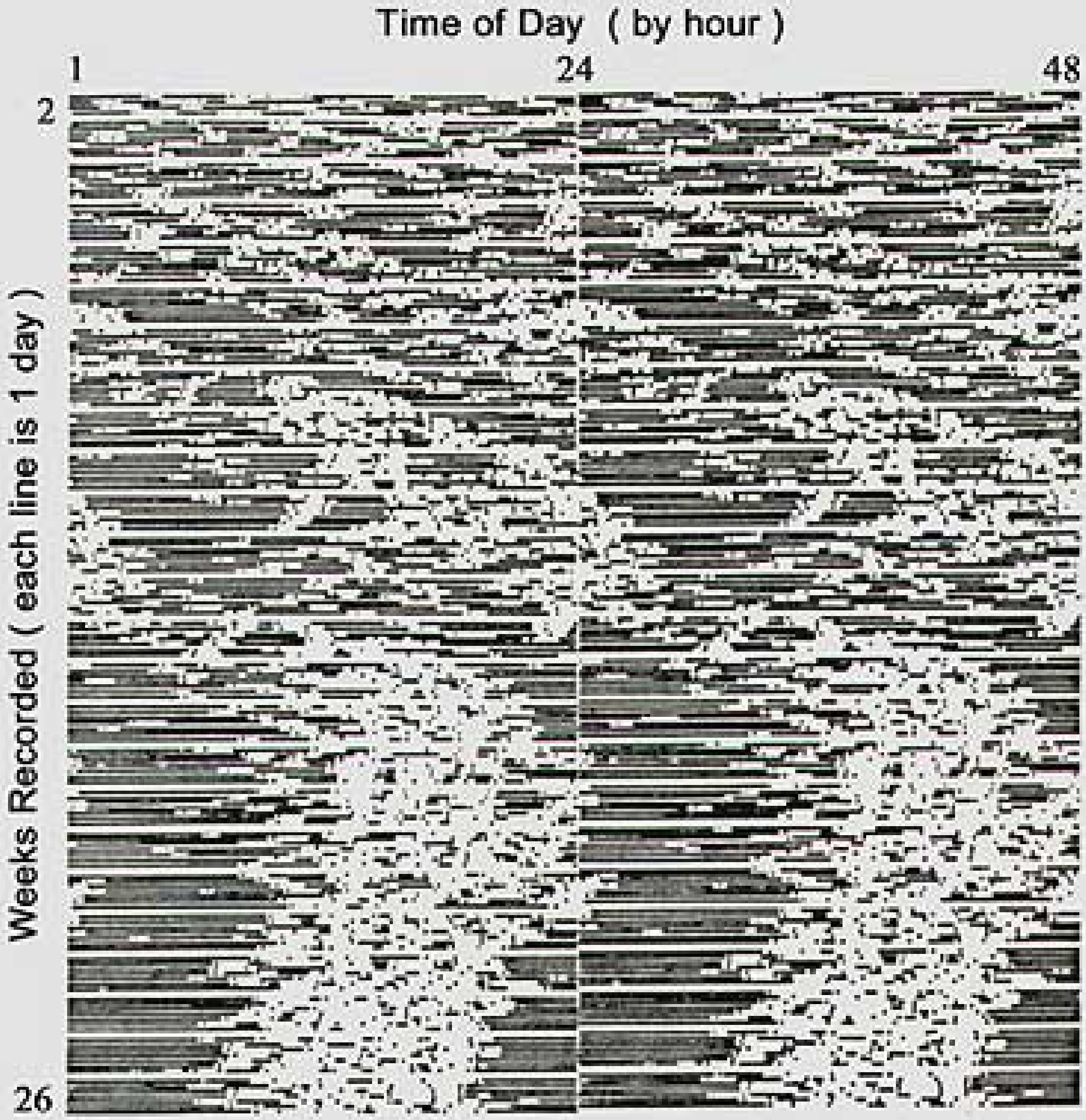
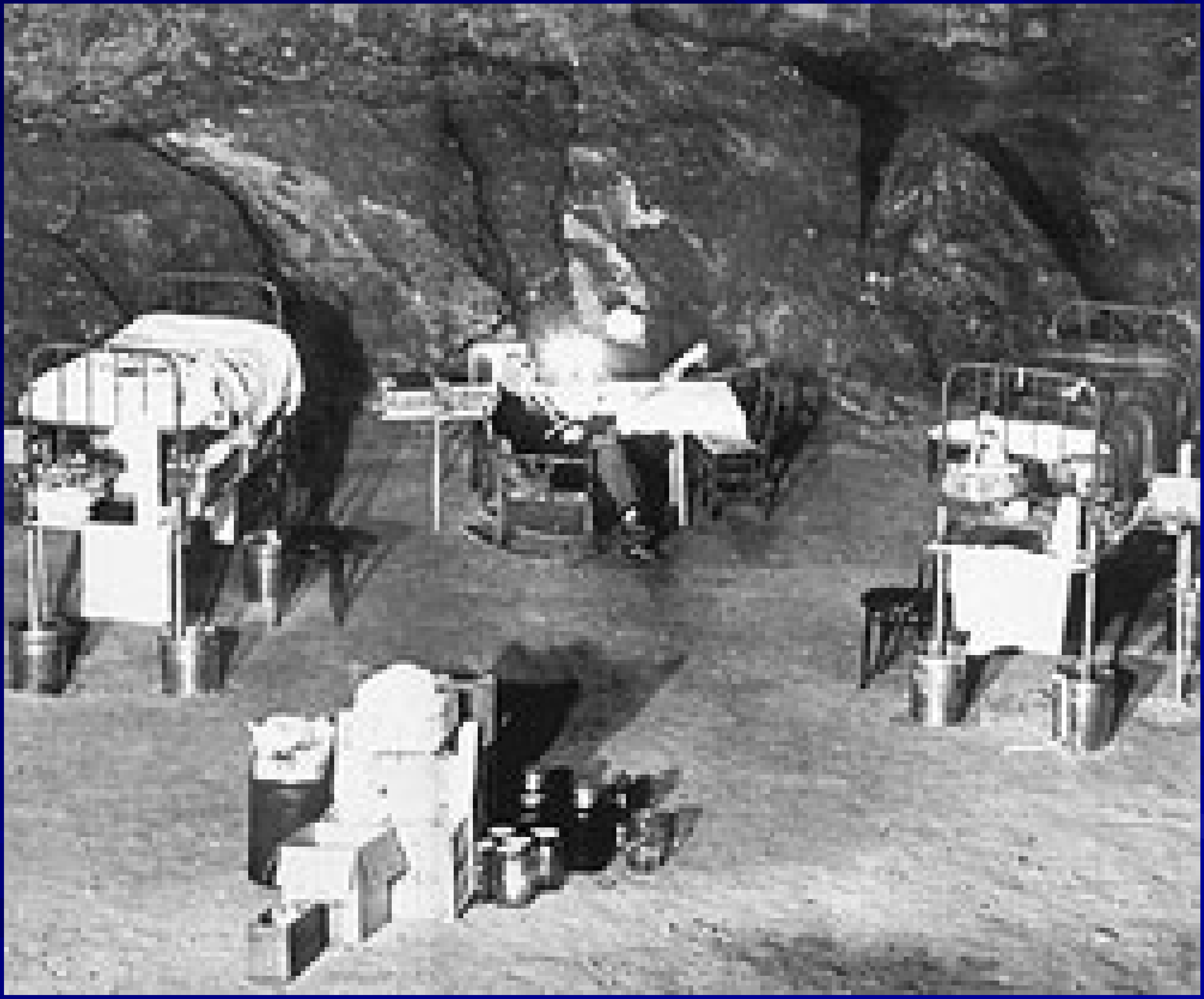
Zeigebers (time givers): cues that entrain circadian rhythms to 24 hours



The sleep-wake record of a human baby. The record is double plotted so that the horizontal axis is 48th; the record extends from the second to the 26th week after birth.

Kleitman & Engelmann, 1953; from the Howard Hughes Museum exhibit, Time Matters

Nathaniel Kleitman and Bruce Richardson after 32 days in Mammoth Cave



The Mammoth Cave, Kentucky, lab in 1938

Cues for Aligning Sleep-Wake Rhythms to a 24 hour light-dark cycle: Zeitgebers

- Bright light: the blue end of the spectrum is the most effective zeitgeber (time-giver). It increases alertness.
- “Dark” is a zeitgeber. It increases sleepiness.
- Daily activity rhythms may have their effect through exposure to light; for example, getting up at 6 am increases exposure to early morning sunlight.

Is consolidated sleep our natural sleep?

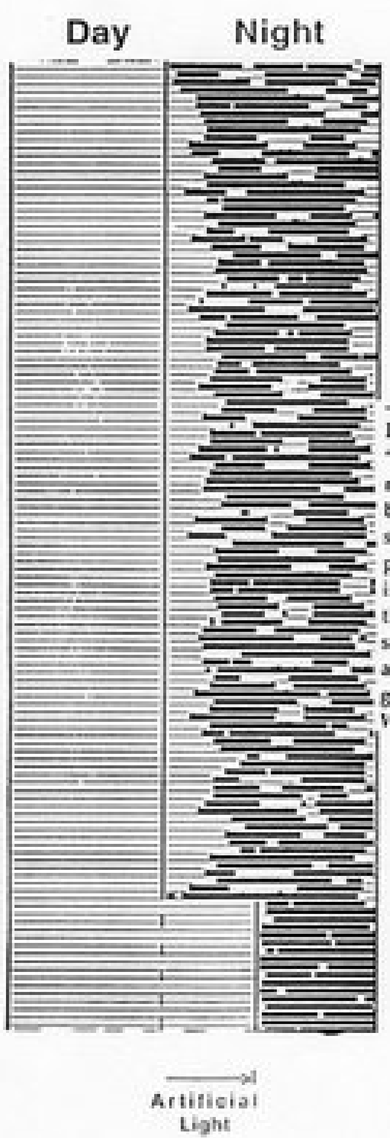
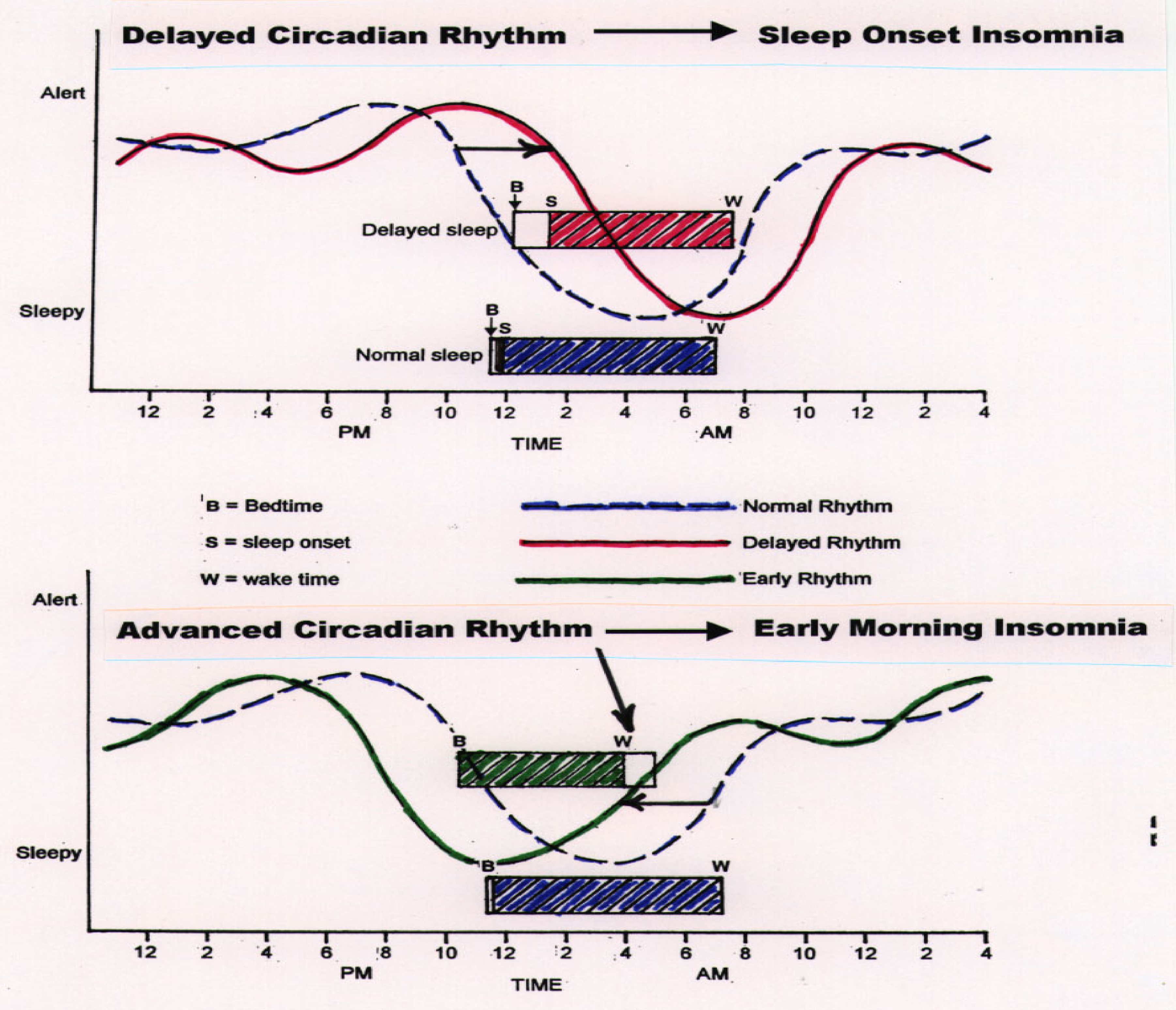


Figure 6. When a young woman slept in long (14-h) artificial "nights" (upper portion of figure), her sleep expanded and separated into two 3- to 5-h bouts with a 1- to 2-h period of wakefulness between them, as was typical of many other individuals. When she slept in conventional short (8-h) artificial "nights" (bottom portion of figure), her sleep was compressed and consolidated, as is considered to be normal. Historical records (see text) indicate that before the Industrial Revolution, many humans slept "from sun to sun," and sometimes in two bouts, like the woman in long artificial scotoperiods. Raster plot shows electroencephalographically monitored sleep as black bars. Data extracted from Wehr et al. (1993).



Delayed Circadian Rhythm → Sleep Onset Insomnia
Alert
Sleepy
B
S
W
Delayed sleep
Normal sleep
12 2 4 6 8 10 12 2 4 6 8 10 12 2 4
PM
AM
TIME
B = Bedtime
S = sleep onset
W = wake time
Normal Rhythm
Delayed Rhythm
Early Rhythm
Advanced Circadian Rhythm → Early Morning Insomnia
Alert
Sleepy
B
W
12 2 4 6 8 10 12 2 4 6 8 10 12 2 4
PM
AM
TIME

Adolescent Use of Mobile Phones for Calling and for Sending Text Messages After Lights Out

Jan Van den Bulck

Sleep, 2007

Levels of Tiredness After One Year of Mobile Phone Use and Time of Inbound and Outbound Text Messages

		Overall level of tiredness (row %)		
		Not tired	**Somewhat tired**	**Very tired**
Use of Text messages and Telephone calls	**N**			
Never	645	43.3%	48.2%	8.5%
Less than once a month	387	38.5%	47.5%	14.0%**
Less than once a week	311	35.4%	49.2%	15.4%***
About once a week	174	25.9%	57.5%	16.7%***
More than once a week	84	21.4%	57.1%	21.4%***
When do you use text messaging?				
Never	645	44.1%	47.9%	8.0%
Right after lights out	547	33.9%	52.5%	13.6%***
Between midnight and 3 am	121	28.1%	52.1%	19.8%***
Any time of the night	121	30.6%	51.2%	18.2%***

** P < 0.001; *** P <0.0001

The Spread of Sleep Loss Influences Drug Use in Adolescent Social Networks

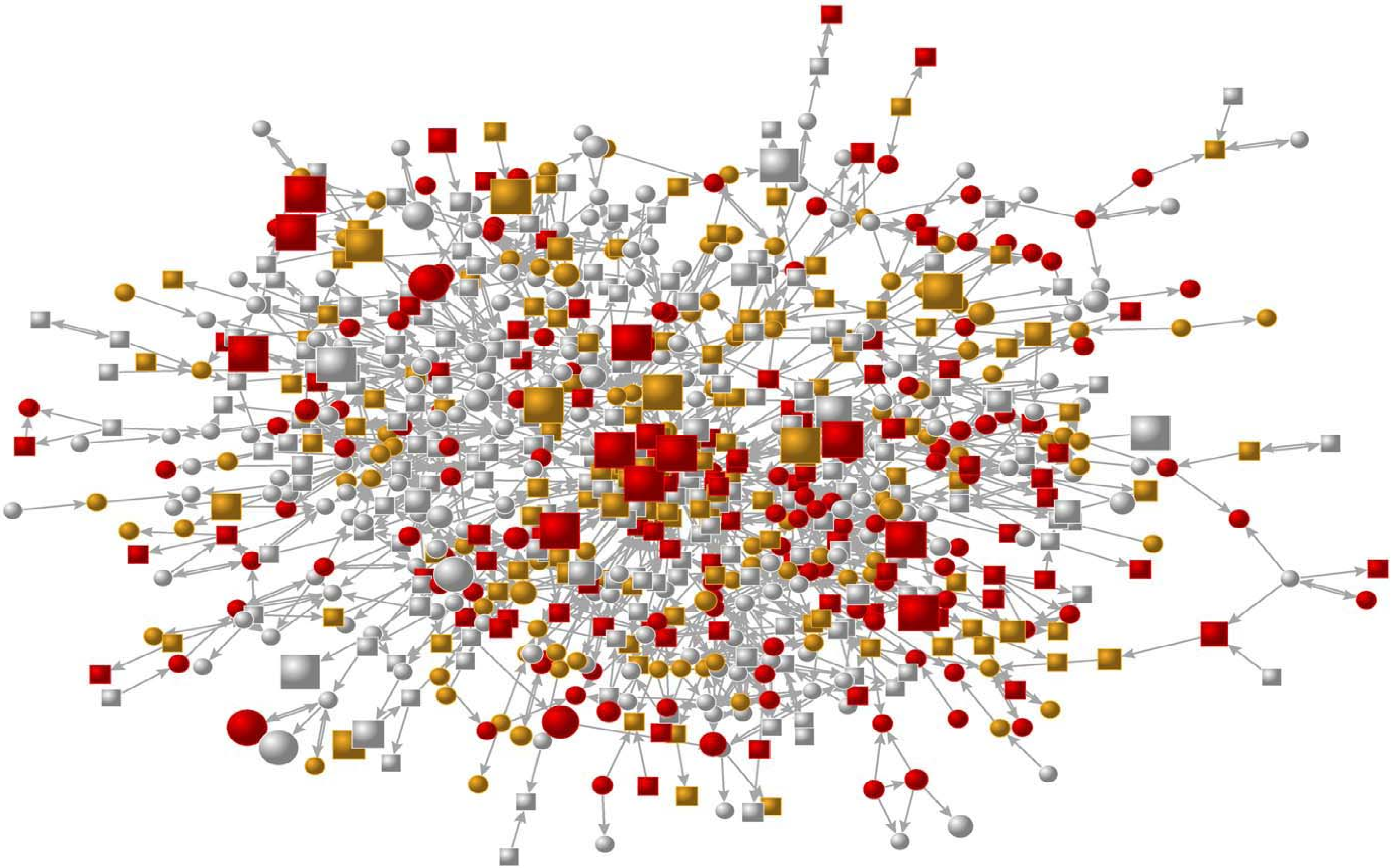
Sara C. Mednick, Nicholas A. Christakis, James H. Fowler

PLoS ONE, 2010

Being central in the network negatively influences future sleep outcomes, but not vice versa.

If a friend sleeps <8 hours, it increases the likelihood a person sleeps <8 hours by 11%. If a friend uses marijuana, it increases the likelihood of marijuana use by 110%.

Moreover, the likelihood that an individual uses drugs increases by 19% when a friend sleeps <8 hours, and a mediation analysis shows that 20% of this effect results from the spread of sleep behavior from one person to another.



Network graph of the largest component of friends in Wave I of the Add Health study (year 1995), from a single school. Each node represents a subject (there are 800 shown) and its shape denotes gender (circles are female, squares are male). Lines between nodes indicate relationships (arrows point from the naming friend to the named friend). Node colour denotes nightly sleep duration (red for 6 hours or less, orange for 7 hours, white for 8 hours or more) and node size indicates frequency of marijuana use (the smallest nodes do not use marijuana, the largest report using at least daily). (Mednick, Christakis, & Fowler, PloS ONE, 2010)

Sleep Extension in High School Students (Cousins, 2008)

19 students (14-18 years old) who extended their sleep > 60 min on 3 consecutive weekday nights showed the following results compared to controls ($p < .05$):

- Better sleep (increased total sleep time and sleep efficiency, decreased difficulty waking in the morning)
- Reduced daytime sleepiness
- Improved backward digit span
- Improved trailmaking B

Conclusions from recent sleep literature

Sleep disturbance is transdiagnostic. It predicts later development of depression, anxiety, substance abuse, and attention deficit disorder.

Sleep affects health, learning, cognition, emotion regulation, and social interaction.

There are rapid advances in neuroimaging and sleep genetics.

An air traffic controller drinks a cup of coffee while working in a terminal radar approach control room.
David Goldman/AP; NPR, April 19, 2011

Air Traffic Control: A Case Study in the Failure to Apply Sleep Science to Public Policy

- Washington Reagan Airport: a supervisor working alone fell asleep and two planes landed without clearance from the control tower. AP March 23, 2011
- "Two more cases of dozing controllers" One found sleeping in LA was suspended, one in Fort Worth seen with his eyes closed was reprimanded. USA TODAY, May 25, 2011

What is the 2-2-1 schedule and why do controllers want it?

- 2 evening shifts--2 PM to 10 PM
- 2 day shifts--6 AM to 2 PM ↔ 8 hrs
- 1 overnight shift—10 PM to 6 AM

This allows for 5 shifts in 4 days resulting in 3 days off. The NTSB tried and failed to eliminate the 2-2-1 schedule in 2007.

FAA Solutions (April, 2011)

- No solo overnight traffic controllers allowed at 27 airports—including DCA
- Rule that the controller must be off of work for at least 8 hours between shifts is expanded to 9 hours
- Scheduled naps will <u>NOT BE ALLOWED</u>

"we're not going to pay controllers to nap." Transportation Secretary Ray LaHood. REUTERS, April 26, 2011

Why no naps?

Charles Czeisler (a renowned sleep and circadian researcher, Harvard University) pointed out that we pay night shift workers, including air traffic controllers, to take bathroom breaks, to eat, to take breaks to smoke. But in the case of air traffic controllers, nap breaks, an effective tool to improve alertness and reduce risk to public safety, are not allowed. NPR , April 23, 2011

Brief naps increase alertness

- *"Ten to fifteen minutes of sleep seems to be the optimum period in terms of improving mental operations, performance, reaction times and subjective feelings of alertness."*
- *"And that improvement in performance and alertness seems to be maintained for up to two and sometimes three hours after the nap."*
- *"Interestingly, the five-minute nap just didn't produce the same amount of improvement, while longer naps of 25 to 30 minutes led to subjects being somewhat drowsy and less alert for up to an hour after the nap."* Leon Lack

- Best time to nap is 6 to 8 hours after awakening.

FAA Rest Rules for Pilots for Flights Longer than 12 Hours

- Flights longer than 9 hours must carry a 3rd pilot to allow for inflight rest

- “For international flights that require more than 12 hours of flight time, air carriers must establish rest periods and provide adequate sleeping facilities outside of the cockpit for in-flight rest.” FAA 1/27/10

Air India Crash May 22, 2010

Capt. Zlatko Glusica was captured snoring loudly on a cockpit recorder, the accident investigation found, according to the *Hindustan Times*.

After waking, Glusica did not respond when his co-pilot H.S. Ahluwalia repeatedly urged him to abort the landing.

Sleep Inertia

- Continuation of the sleep state into wakefulness
  - Cognitive confusion
  - Automatic behavior
  - Amnesia for what was said and done
  - Worse after prior sleep deprivation
  - Worse after awakenings from slow-wave sleep

Sleepiness and Fatigue Affect Many Critical Activities

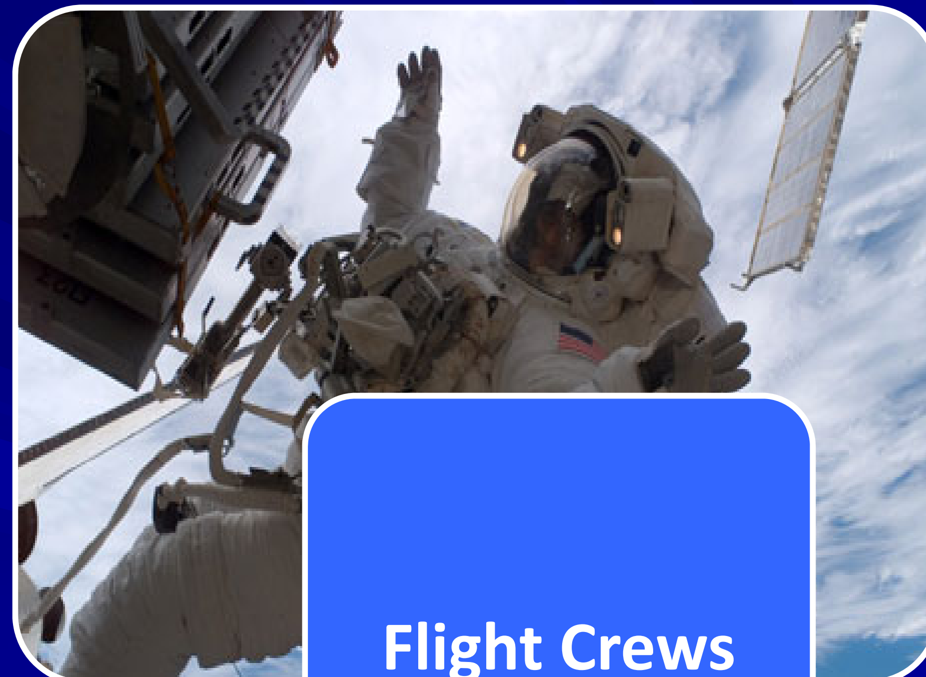
- Transportation accidents
- Education
  - School start times
  - Morning classes in college
- Medical resident work hours
- Shift work
- Military operations
- Jet lag

Sleep Risk

Risk of Performance Errors Due to Fatigue Resulting from Sleep Loss, Circadian Desynchronization, Extended Wakefulness and Work Overload

Ground Crews

- **Medical Operations**
- **Mission Operations**



Flight Crews

Richard R. Bootzin[1,2], Ph.D., Patricia Dalby[3], Ph.D., Patricia Haynes[2], Ph.D., and Keith Fridel[1], M.A.
Departments of Psychology[1], Psychiatry[2], Orthopaedic Surgery[3]

Chris MacDonald-RAAM 2005

Rookie of the Year:

'Rookie of the Year' award goes to **Chris MacDonald**, 32, (DEN) marking the third consecutive year a rookie has placed 2nd in RAAM. **With a strategy of sleeping during the hottest parts of the day, obtaining more sleep than his nearest rival,** Fabio Biasiolo (ITA)…


66
Insight
INDOOR CYCLE
Insight
RACE ACROSS AMERICA
PARENTINI
maxim
COLNAGO
199

Hallucinations/Delusions

- Reports from previous RAAM races—usually from first-time racers
  - Loss of memory for a period of time and rider persuaded that his crew consists of aliens
  - Mailboxes on the side of the road “seen” as spectators encouraging the rider to get off the bike
  - Crowds “seen” applauding the rider as if he is at finish line

Chris's Dream

- While cycling almost immediately after a short rest stop, Chris believed that he was still asleep and dreaming that he was cycling. He concluded that the only way he could stop the dream was to stop cycling. He then rode his bike into a ditch.
  - Dream confusion due to sleep inertia?
  - Crew insisted that Chris take a longer sleep break

Countermeasures for Sleepiness and Fatigue (Veasey, et al., JAMA, 2002) Most vulnerable time: 2 – 9 am

Sleep:

- 2-8 hr nap prior to 24 hrs of sleep loss
- 15 min nap every 2 to 3 hrs maintains performance during 24 hrs of sleep deprivation
- 2 hr naps every 12 hrs maintains performance during 88 hrs of sleep deprivation
- Naps need to be < 2 hrs to avoid sleep inertia

Countermeasures for Sleepiness and Fatigue (Veasey, et al., JAMA, 2002) Most vulnerable time: 2 – 9 am

Stimulants

- High-dose caffeine, modafinil, and D-amphetamine are effective for short-term sleep loss (< than 48 hrs) but not for long term sleep loss.

Other Countermeasures that Reduce Sleepiness

- A consistent sleep-wake schedule reduces sleepiness compared to having an irregular schedule with the same amount of sleep (Manber, Bootzin, et al. 1996)
- Interesting activities increase alertness; boring activities increase sleepiness.
- Social interaction increases alertness.

Sensory Stimulation

- Sensory stimulation (sight, hearing, taste, smell, touch—also sensitivity to heat, balance, internal sensations) increases arousal

Irregular schedules lead to the development of
sleep disturbance and
problems with sleepiness

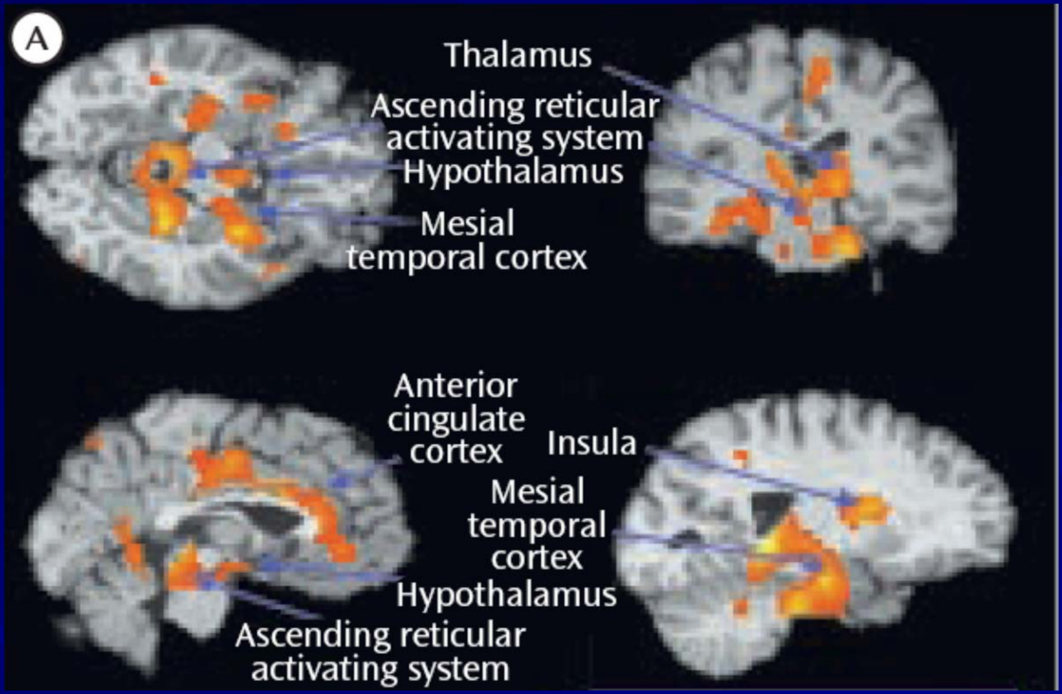
Causes of Sleep Disturbance

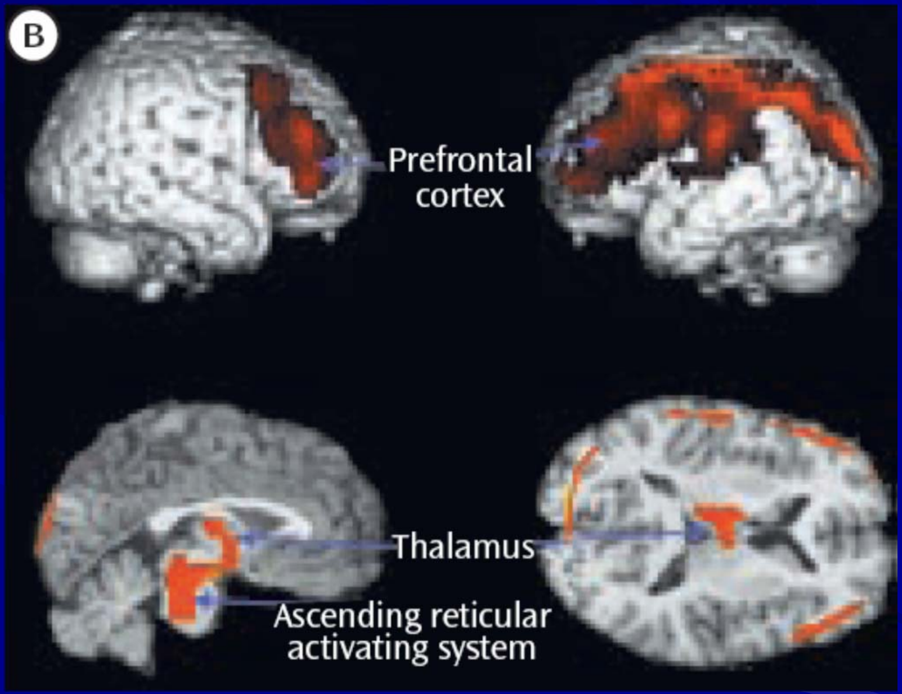
- Physical disorders (sleep apnea, chronic pain, restless legs, PLMS, GERD)
- Substances (legal and illegal substances)
- Circadian rhythm problems (shift work, jet lag, advanced or delayed sleep phases)
- Psychological factors (stress, psychopathology, nightmares)
- Poor sleep environment (noise, ambient temperature, bed partner)
- Poor sleep habits (irregular sleep schedule, naps, bed as a cue for arousal, extended time in bed)

Neuroimaging of Arousal in Insomnia

Areas with <u>less decrease</u> in metabolic rate while asleep in insomniacs

Areas with <u>more decrease</u> in metabolic rate while awake in insomniacs





Some brain areas "stay awake" during sleep

Some brain areas are less available during wake

Nofzinger et al., 2004, *Am J Psychiatry*

Consequences of Insomnia

- Feel less physically well; more often visit physicians
- Have more absences from work due to illness
- Have more trouble with memory, concentration, and performance
- Have more work-related accidents and injuries
- Increases risk for major depression and alcohol and substance abuse

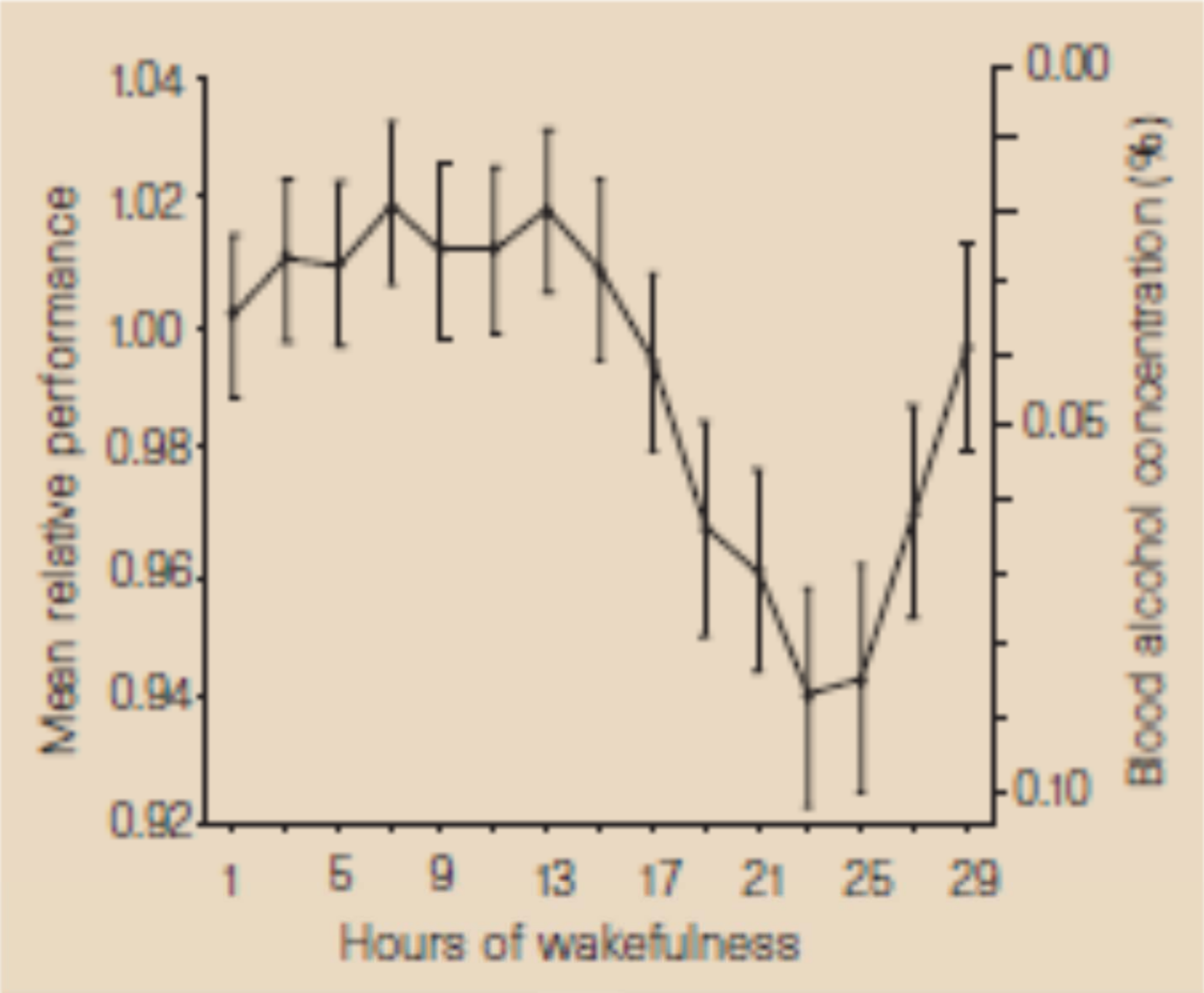


Figure 2 Performance in the sustained wakefulness condition expressed as mean relative performance and the percentage blood alcohol concentration equivalent. Error bars ± s.e.m.

Dawson & Reid, *Nature*, 1997.

Prevalence of Insomnia

- 1-month insomnia—lifetime prevalence
  - Women: 31.1%
  - Men: 17.5%
- 2-3 week insomnia—lifetime prevalence
  - Women: 14.4%
  - Men: 12.0%
- No insomnia—lifetime prevalence
  - Women: 19.1%
  - Men: 25.7%

Buysse, et al., *Sleep*, 2008

Recommended Reading

Bootzin, R.R., & Epstein, D.R. (2011). Understanding and treating insomnia. *Annual Review of Clinical Psychology,* **7**, 435-458.

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