Normal Sleep: Impact of Age, Circadian Rhythms, and Sleep Debt

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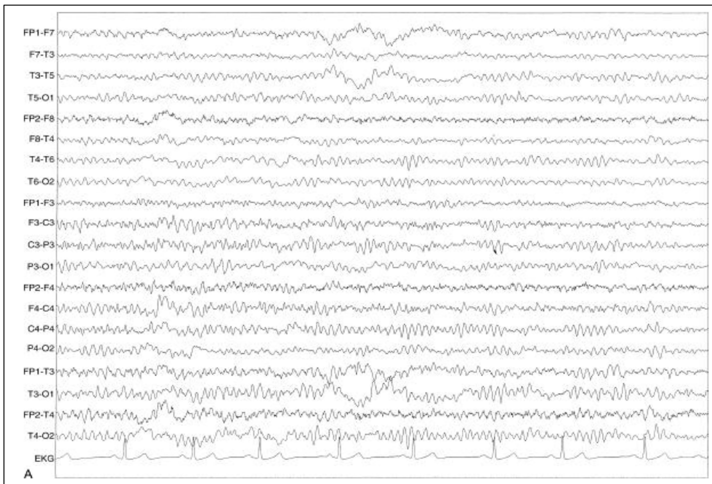
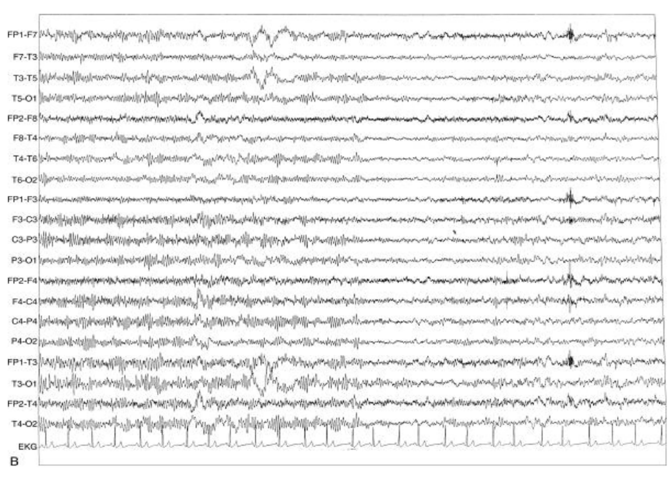
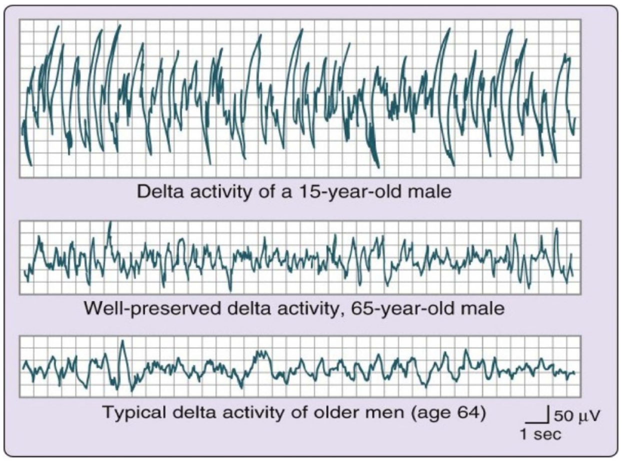
뇌파의 변화

- Awake
  - Slowing of alpha activity
  - Increase of fast activity
  - Diffuse or focal slowing
- Sleep
  - Decreased amplitude of slow wave
  - Decreased frequency of sleep spindle



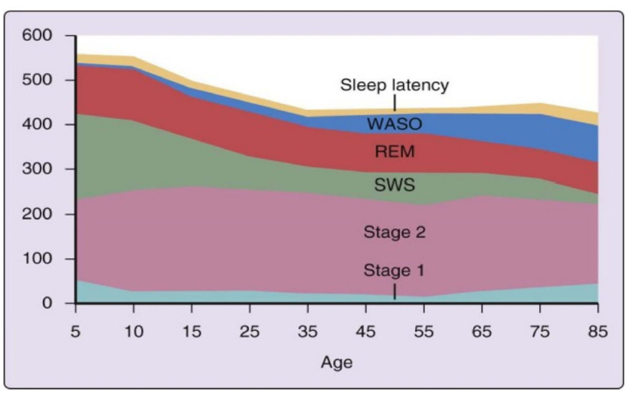




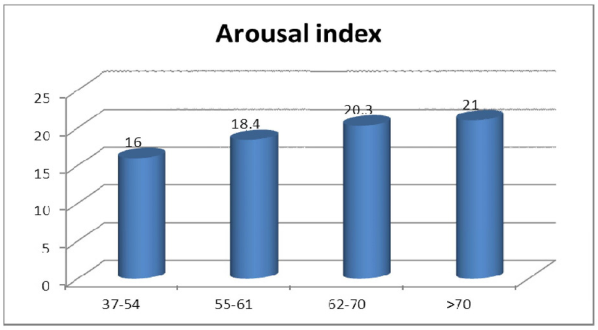
노인 수면의변화

- 비렘서파수면의 감소
- 렘수면밀도와 총 렘수면시간의 감소
- 총 수면시간 중 렘수면의 비율은 유지
- 수면 분절

Changes in sleep with age



Arousal Index: Brief Arousals per Hour of Sleep



일주기 리듬의 변화

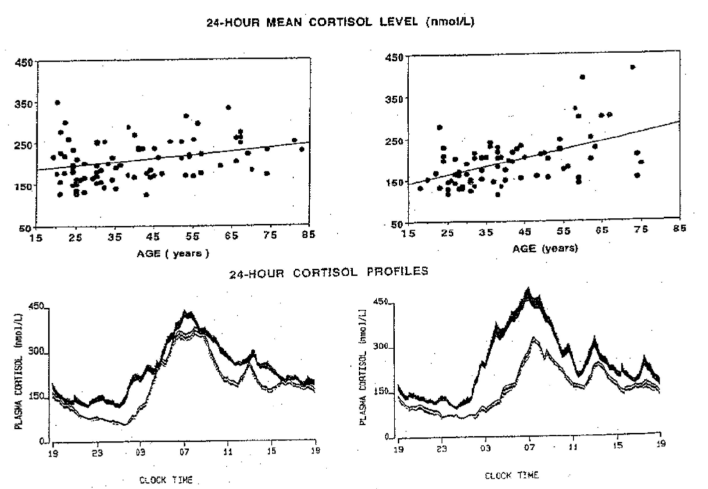
- 사회적 활동의 근본적 변화에 기인
- 병리적인 변화
  - Suprachiasmatic nucleus, brainstem
- 시설 거주
- 전진수면위상 (advanced sleep phase)

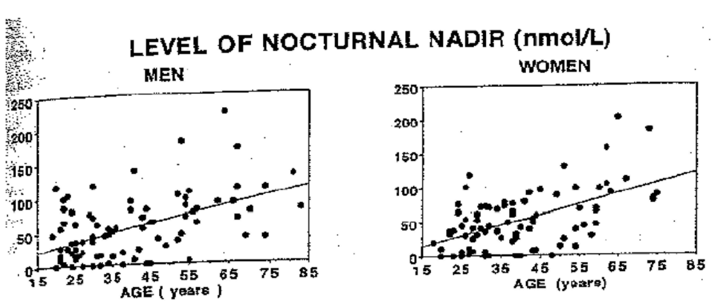
자율신경계의 변화

- 노에피네프린 증가, 근육의 교감신경 활성화
- 반응성 감소
- 체온조절기능의 감소, 외부 열에 대한 발한 감소

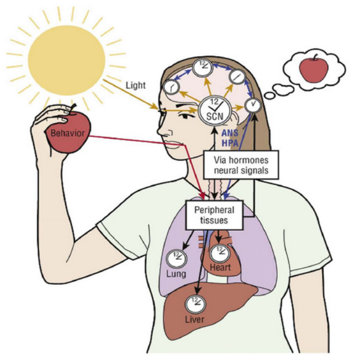
호르몬의 변화

- 코티졸 일주기 리듬의 유지
- 야간 코티졸 농도의 증가, 아침의 상승 시간이 앞당겨짐
- 성장호르몬 분비 감소
- 혈청 멜라토닌의 감소



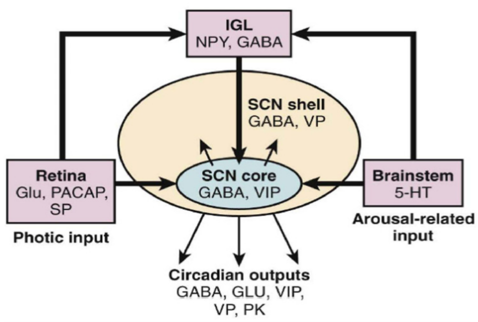


Circadian rhythm

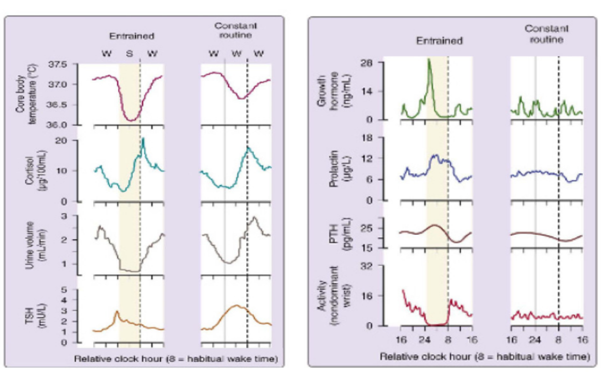


Multiple oscillatory nature of circadian rhythm

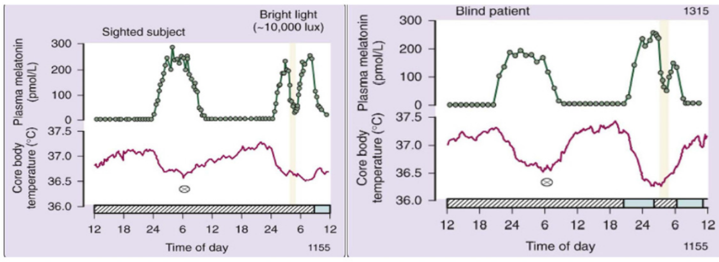
Master Circadian Pacemaker



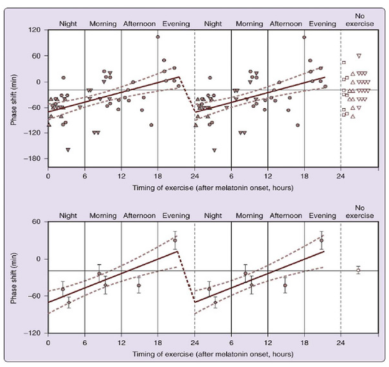
Influence of Sleep and Circadian Rhythms on Human Physiology



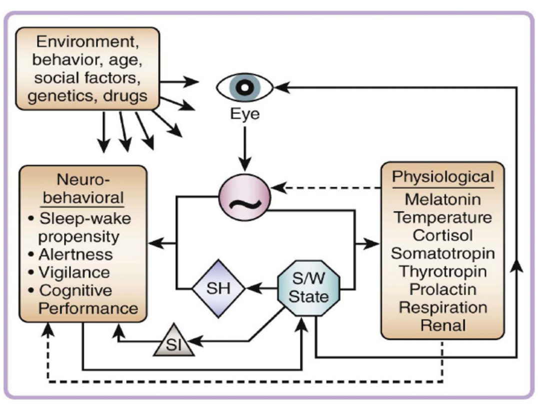
Effects of Light on Circadian Rhythms



Nonphotic Circadian Phase Resetting and Reentrainment



Phase-response curves in response to excercise



Circadian Rhythms Sleep Disorders of endogenous origin

- ASPS (Advanced sleep phase syndrome)
- DSPS (Delayed sleep phase syndrome)
- Non 24-hour slee wake disorder
- Irregular sleep-wake pattern
- Blindness
- Aging

Secondary Circadian Dysrhythmias

- Shift work
- Zeg lag

CNS Disorders associated with alteration of melatonin secretion

- Pinealectomy
- Alzheimer's Disease
- Mood Disorders
- Other Pathologic Conditions
  - Low melatonin level
    - Acute intermittent porphyria
    - Epilepsy
    - Migraine and cluster headache
  - Inversed circadin rhythm of melatonin secretion
    - Smith-Magenis syndome (Ch 17)

Role of sleep

- Brain thermoregulation
- Brain detoxification
- Tissue "restoration"
- Brain plasticity for learning and memory

Use-dependent Vs experience-dependent processes

- Use-dependent process
  - Restoration of neuronal function after sustained waking activity
  - Contralateral hand prolonged vibratory stimulation → increased central slow wave activity during SWS
  - Short-term adaptations to waking activity
- Experience-dependent process
  - New environment (stimulus, task)
  - Long-term behavioral changes

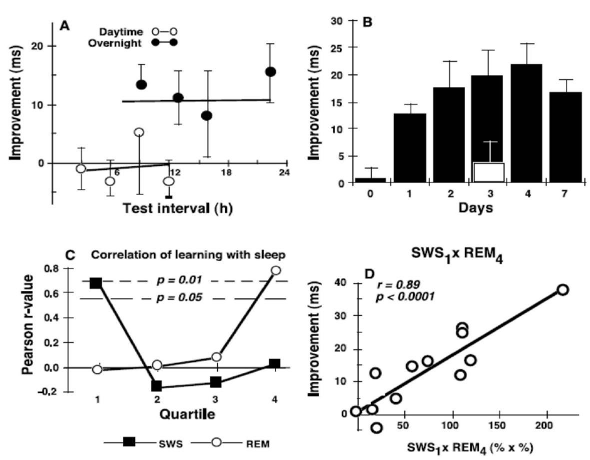
Sleep and memory processes-Behavioral level

- Post-training sleep deprivation → impaired subsequent performance
  - Specific to new behavioral strategy
  - Specific to REM sleep
- Change of general architecture of sleep alter during the post-training night

REM VS SWS

- Dual process
  - SWS deprivation specifically impairs explicit memories *whereas* REM sleep deprivation is more deleterious for implicit learning
- Double step process
  - learning would require the memory trace to be processed first in SWS, and then in REM sleep.
  - First half SWS, REM in the second half

- REM Vs SWS
  - Consolidation of procedural learning not declarative learning VS explicit learning
- Visual texture discrimination task
  - Needs both SWS and REM



Chronobiol Int. 2010 August ; 27(7): 1469–1492. doi:10.3109/07420528.2010.503293.

MODIFICATIONS TO WEEKEND RECOVERY SLEEP DELAY CIRCADIAN PHASE IN OLDER ADOLESCENTS

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Abstract

Adolescents often report shorter time in bed and earlier wake-up times on school days compared to weekend days. Extending sleep on weekend nights may reflect a "recovery" process as youngsters try to compensate for an accumulated school-week sleep debt. The authors examined whether the circadian timing system of adolescents shifted after keeping a common late weekend "recovery" sleep schedule; it was hypothesized that a circadian phase delay shift would follow this later and longer weekend sleep. The second aim of this study was to test whether modifying sleep timing or light exposure on weekends while still providing recovery sleep can stabilize the circadian system. Two experiments addressed these aims. Experiment 1 was a 4-wk, within-subjects counterbalanced design comparing two weekend sleep schedule conditions, "TYPICAL" and "NAP." Compared to weeknights, participants retired 1.5 h later and woke 3 h later on TYPICAL weekends but 1 h later on NAP weekends, which also included a 2-h afternoon nap. Experiment 2 was a 2-wk, between-subjects design with two groups ("TYPICAL" or "LIGHT") that differed by weekend morning light exposure. TYPICAL and LIGHT groups followed the TYPICAL weekend schedule of Experiment 1, and the LIGHT group received 1 h of light (454–484 nm) upon weekend wake-up. Weekend time in bed was 1.5 h longer/night than week-nights in both experimental protocols. Participants slept at home during the study. Dim light melatonin onset (DLMO) phase was assessed in the laboratory before (Friday) and after (Sunday) each weekend. Participants were ages 15 to 17 yrs. Twelve participants (4 boys) were included in Experiment 1, and 33 (10 boys) were included in Experiment 2. DLMO phase delayed over TYPICAL weekends in Experiment 1 by (mean ± SD) 45 ± 31 min and Experiment 2 by 46 ± 34 min. DLMO phase also delayed over NAP weekends (41 ± 34 min) and did not differ from the TYPICAL condition of Experiment 1. DLMO phase delayed over LIGHT weekends (38 ± 28 min) and did not differ from the TYPICAL group of Experiment 2. In summary, adolescents phase delay after keeping a commonly observed weekend sleep schedule. Waking earlier or exposure to short-wavelength light on weekend mornings, however, did not stabilize circadian timing in this

J. Sleep Res. (2008) 17, 432–436 Measures to counteract evening sleepiness

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Sleep extension versus nap or coffee, within the context of 'sleep debt'

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SUMMARY Though extended night-time sleep mostly reduces the 'afternoon dip', little is known about evening benefits to alertness, or about comparisons with an afternoon nap or caffeine. Twenty healthy carefully screened adults, normal waking alertness levels, underwent four counterbalanced conditions: usual night sleep; night sleep extended < 90 min (usual bed-time); up to 20 min afternoon nap; and 150 mg afternoon caffeine (versus decaffeinated coffee). Sleepiness was measured by afternoon and evening multiple sleep latency test (MSLTs), longer psychomotor vigilance test (PVT) sessions and a subjective sleepiness scale. Sleep was extended by average of 74 min, and all participants could nap 15–20 min. Sleep extension had little effect on PVT determined modest levels of morning sleepiness. Afternoon and evening MSLTs showed all active treatments significantly reduced the 'dip', with nap most effective until mid-evening; next effective was caffeine, then extension. Late evening sleepiness and subsequent sleep did not differ between conditions. Arguably, participants may have experienced some 'sleep debt', given they extended sleep and reflected some sleepiness within settings sensitive to sleepiness. Nevertheless, extended sleep seemed largely superfluous and inefficient in reducing modest levels of sleepiness when compared with a timely nap, and even caffeine. Sleep, such as food and fluid intakes, can be taken to excess of real biological needs, and for many healthy adults, there is a level of modest daytime sleepiness, only unmasked by very sensitive laboratory measures. It may reflect a requirement for more sleep or simply be within the bounds of normal acceptability.

KEYWORDS caffeine, multiple sleep latency test, nap, psychomotor vigilance test, sleep extension, sleepiness

PROFESSIONAL ISSUES

Working the night shift: preparation, survival and recovery – a guide for junior doctors

Clin Med 2006;**6**:61–67

Nicholas Horrocks and Roy Pounder, on behalf of an RCP Working Group

- Preparing for the night shift
  - Successful sleep at home
  - Getting plenty of sleep before your first night shift
  - Taking an afternoon sleep
- Surviving the night shift
  - Maintaining your alertness and vigilance while on duty
  - Napping while on duty
  - Bright light
  - Eating at night
  - Caffeine
- Recovering from the night shift
  - Getting home from work
  - Working further night shifts
  - Befor you go to bed
  - Recovery after your final night shift