睡眠障礙檢查與儀器感測原理

The Tests of Sleep disorders and The Principles of Signals Measurement

台中榮總胸腔內科

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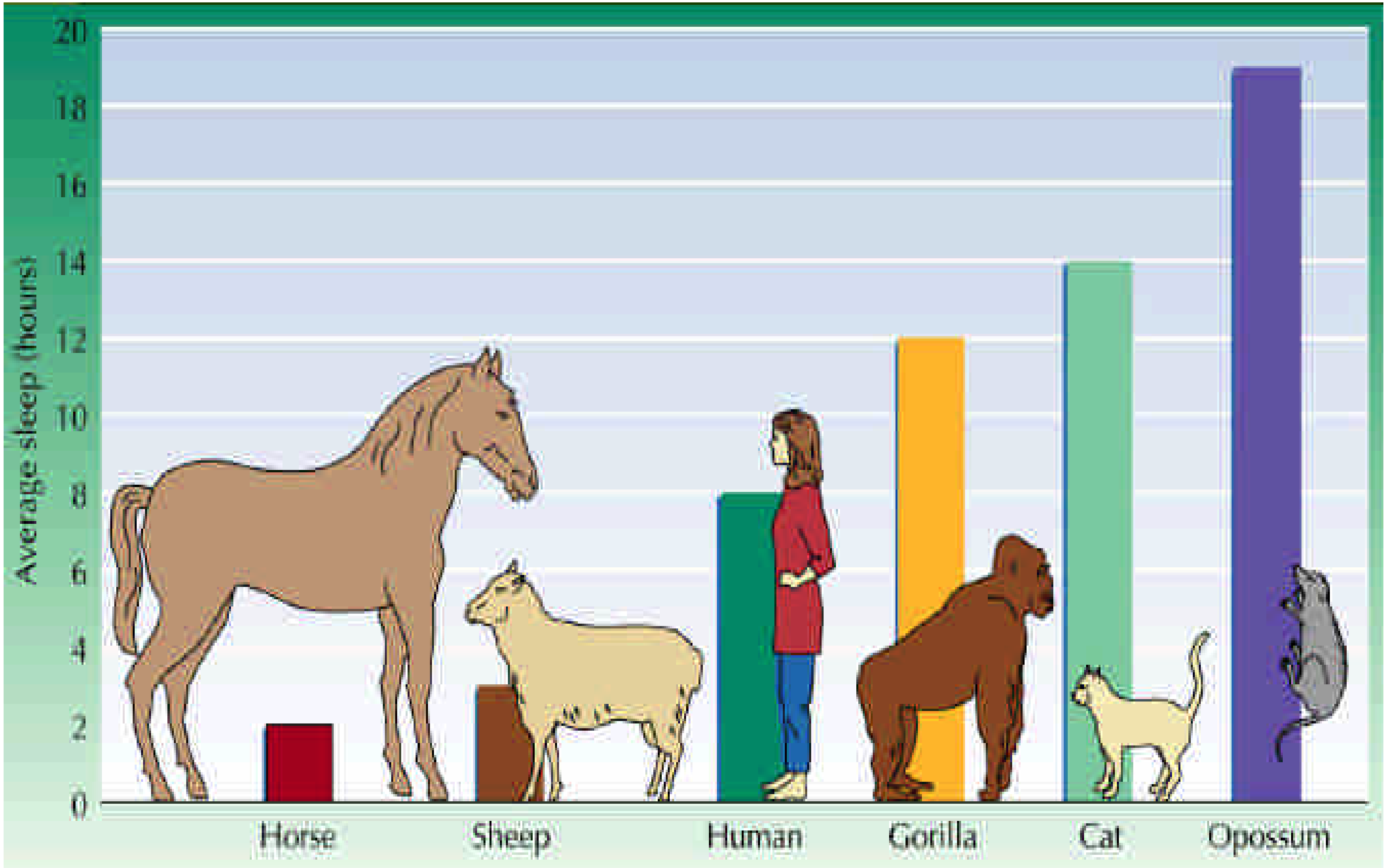
台中市醫事檢驗師公會九十九年度第五場次繼續教育研討會 **Nov 28, 2010**

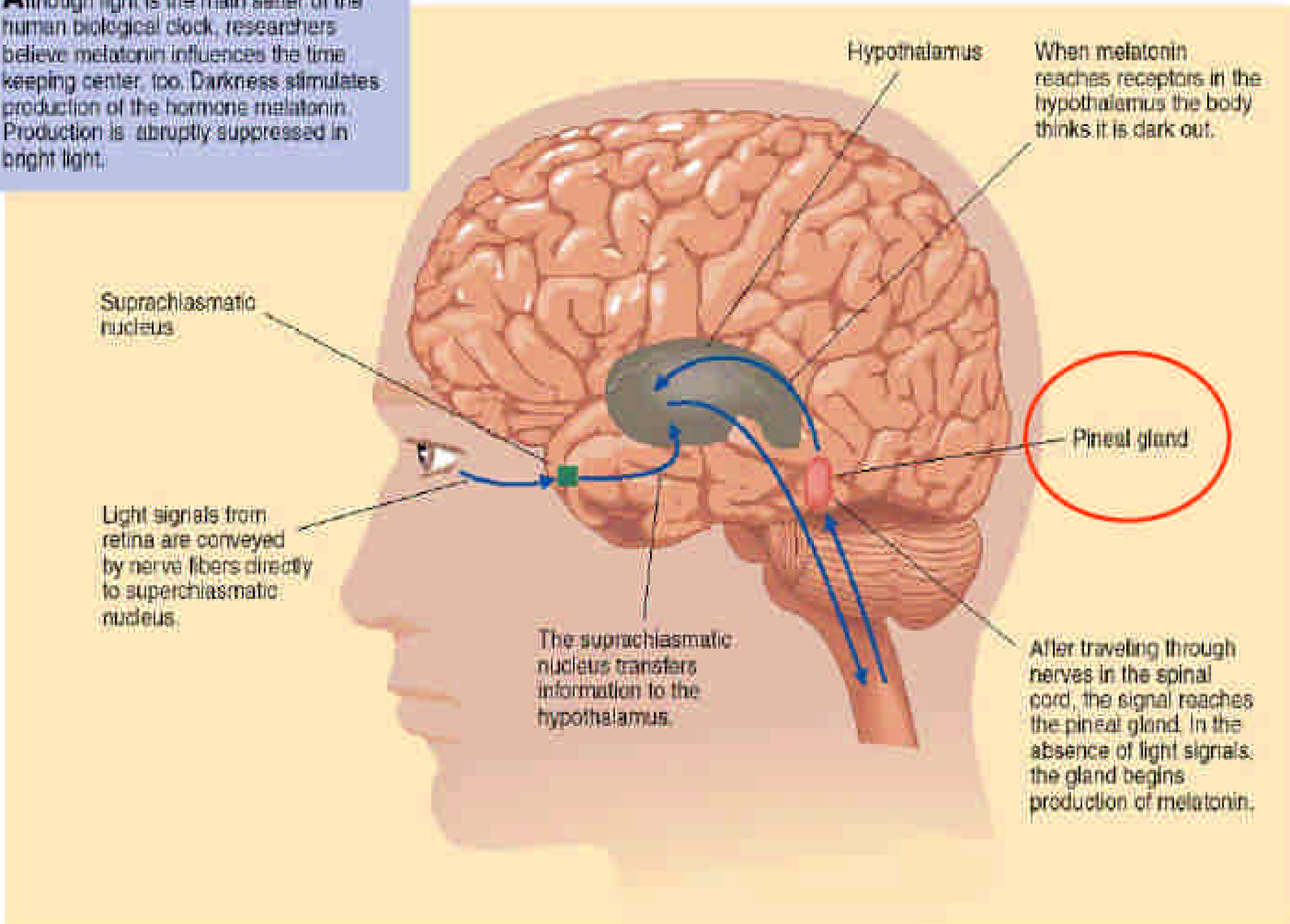
Outline

- The overview of Sleep Physiology
- Sleep Disorders
- Polysomnography and The Signals Measurement
- Interesting Studies

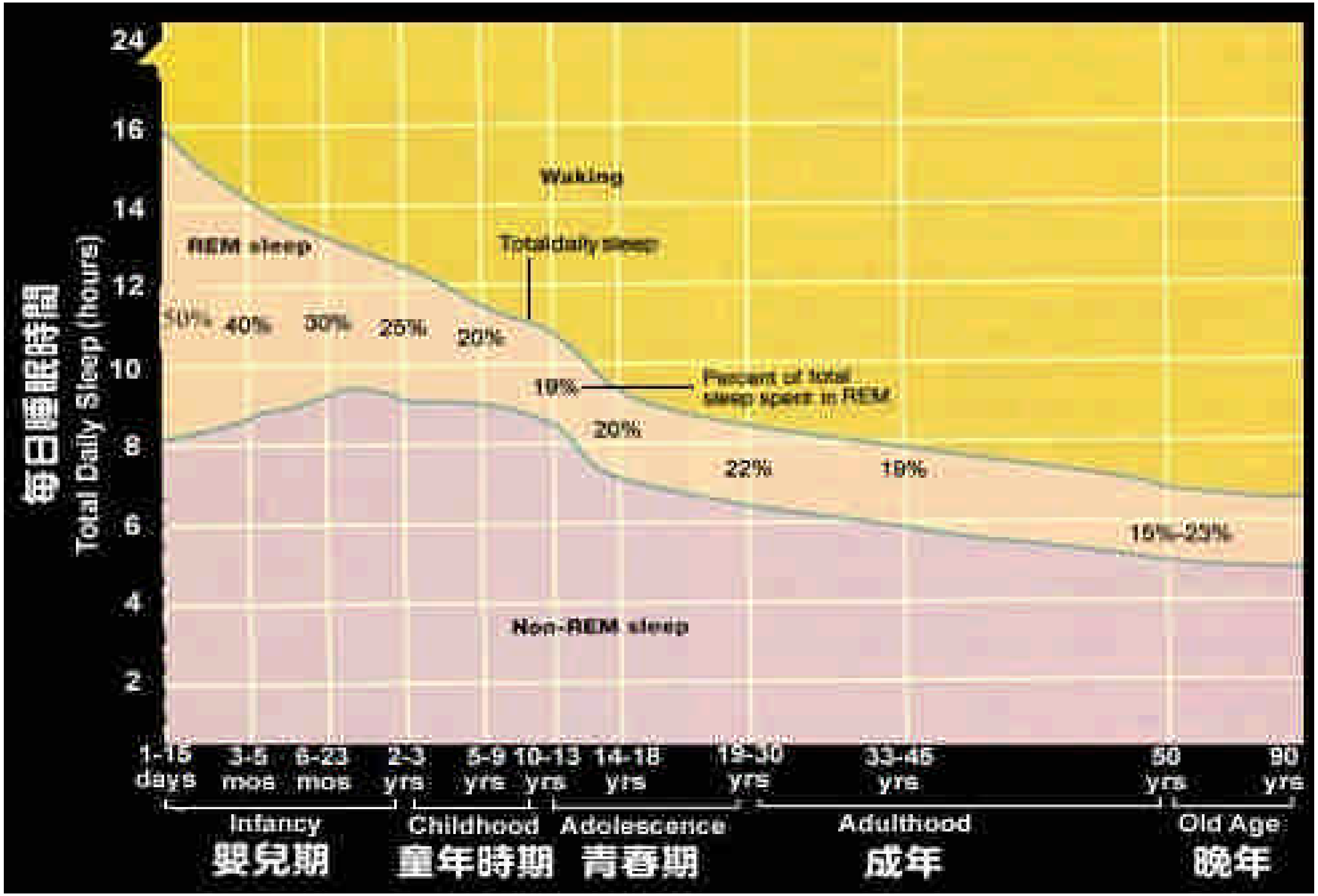
The overview of Sleep Physiology(1/5)



Although light is the main setter of the human biological clock, researchers believe melatonin influences the time keeping center, too. Darkness stimulates production of the hormone melatonin. Production is abruptly suppressed in bright light.



The overview of Sleep Physiology(2/5)

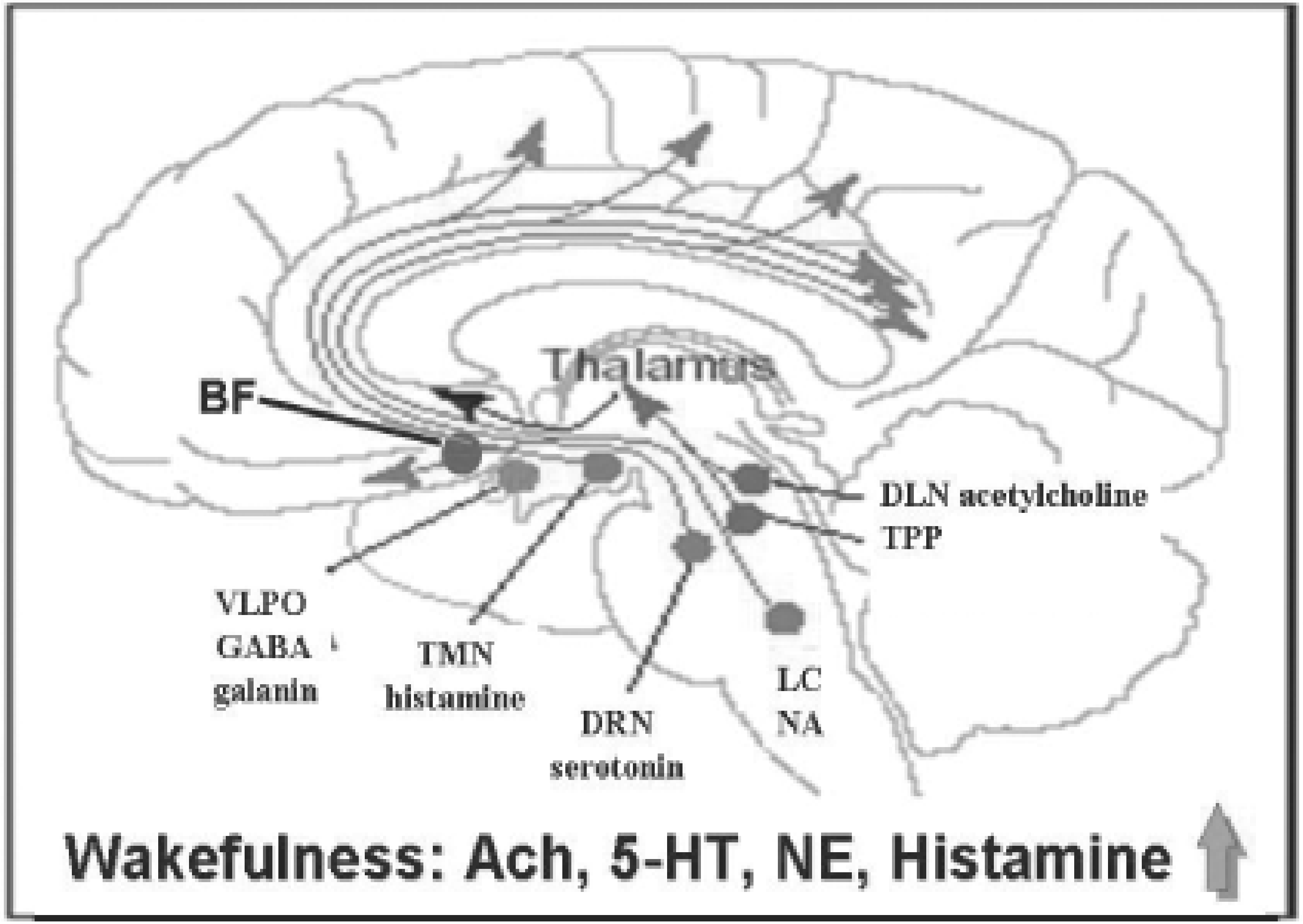


The overview of Sleep Physiology(3/5)

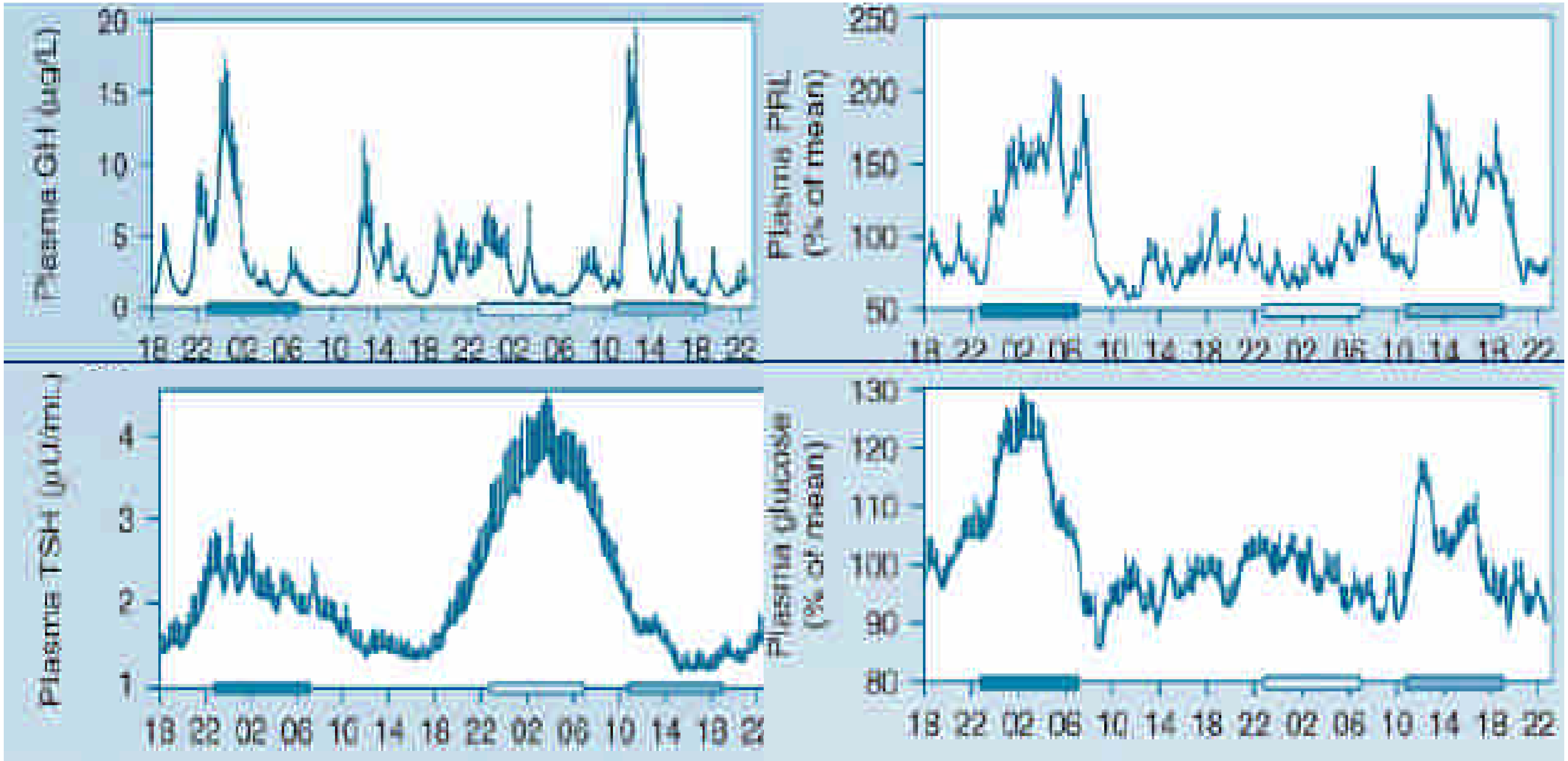
Activity of wake and sleep centers

	wake	NREM sleep	REM sleep
LDT/PPT (Acetylcholine)	↑↑	—	↑↑
LC (Norepinephrine) DR (5-HT) TMN (Histamine) SN/VTA (Dopamine)	↑↑	↑	—
Lateral hypothalamus (Orexin/Hypocretin)	↑↑	—	—
VLPO (Galanin & GABA)		↑↑	—
VLPO-extended (Galanin & GABA)	—	—	↑↑

Adapted from Clinics in Chest Medicine June 2010

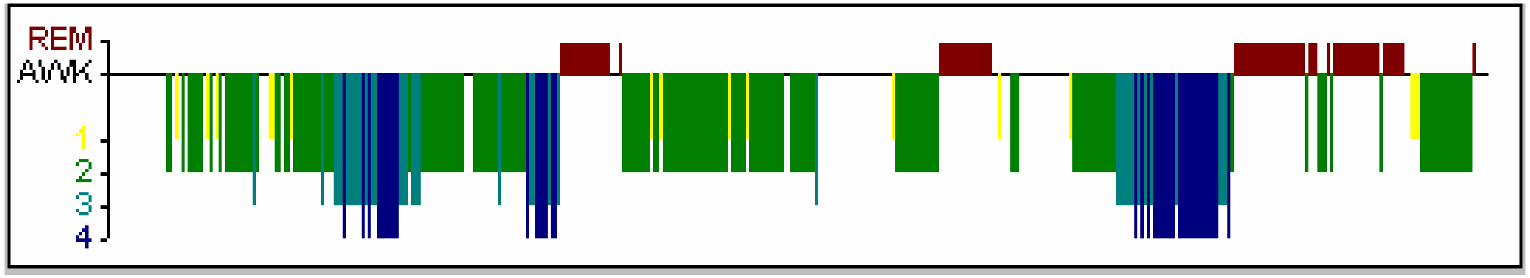

Thalamus
BF
DLN acetylcholine
TPP
VLPO
GABA
galanin
TMN
histamine
DRN
serotonin
LC
NA
Wakefulness: Ach, 5-HT, NE, Histamine

The overview of Sleep Physiology(4/5)



The overview of Sleep Physiology(5/5)

- Normal Sleep Architecture



Sleep Disorders (1/2)

The classification of sleep disorders (ICSD2),
American Academy of Sleep Medicine, AASM (2005)

(1) INSOMNIA :

Adjustment Insomnia ,Inadequate Sleep Hygiene ..

(2)PARASOMNIA :

Sleepwalking ,Sleep Terrors ,REM Sleep Behaviour Disorder ..

(3)HYPERSOMNIA OF CENTRAL ORIGIN NOT DUE TO A CIRCADIAN RHYTHM DISORDER, OR OTHER CAUSE OF DISTURBED NOCTURNAL SLEEP :

Narcolepsy With Cataplexy…

(4)SLEEP RELATED BREATHING DISORDERS :

Primary Central Sleep apnoea ,Sleep Related Hypoventilation/ Hypoxaemic syndromes …

Sleep Disorders (2/2)

(5)SLEEP RELATED MOVEMENT DISORDER:

Restless Legs Syndrome ,Periodic Limb Movement Disorder …

(6)ISOLATED SYMPTOMS, APPARENTLY NORMAL VARIANTS AND UNRESOLVED ISSUES:

Snoring ,Sleep talking…

(7)OTHER SLEEP DISORDERS :

Environmental Sleep Disorder **. . .**

(8)CIRCADIAN RHYTHM SLEEP DISORDER:

Irregular Sleep-Wake Type ,Jet Lag Type ,Shift Work Type **…**

Polysomnography and the Signals Measurement (1/17)

The American Academy of Sleep Medicine has classified sleep study systems into four categories

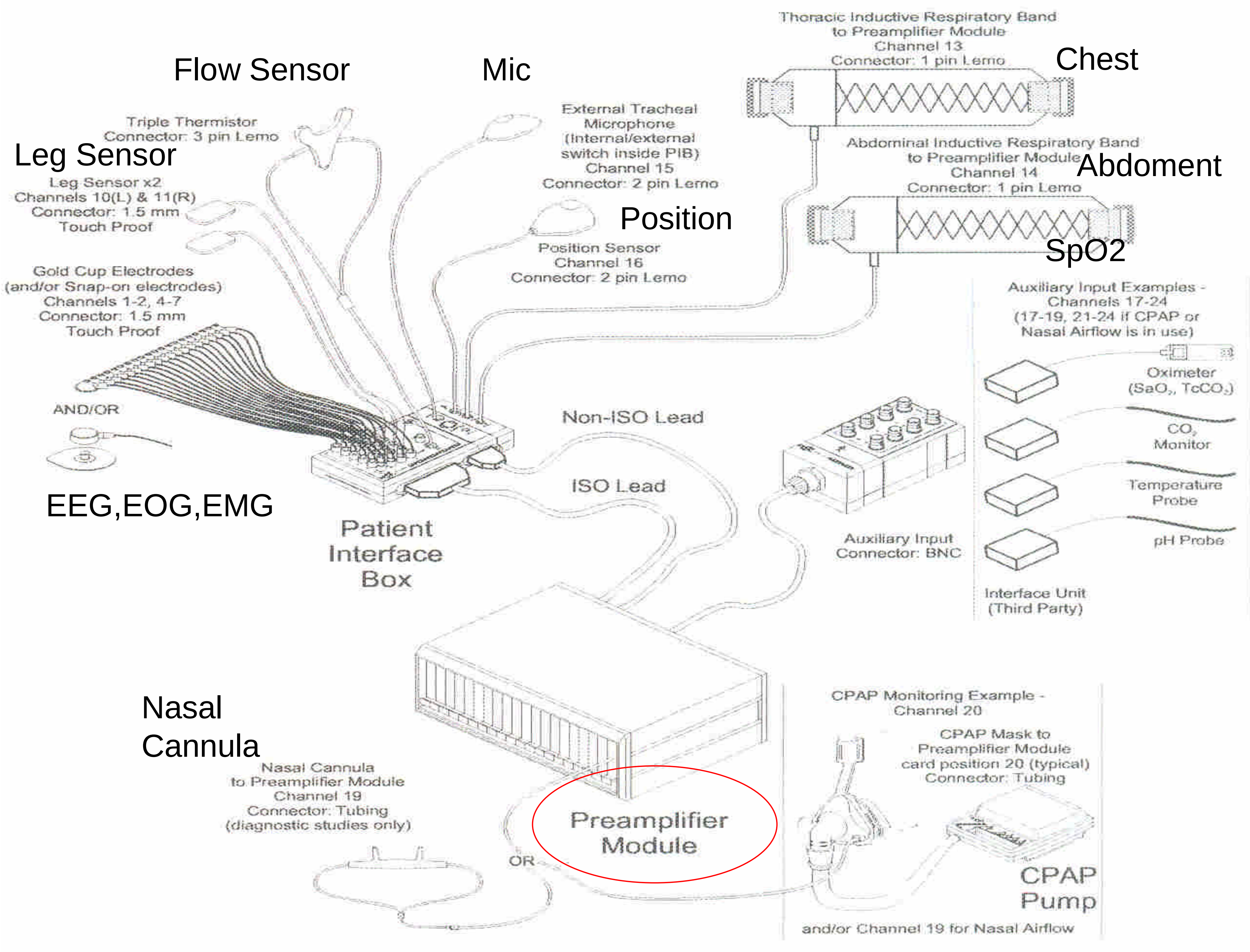
Level 1: in-laboratory attended standard PSG

Level 2: unattended-home sleep study with comprehensive portable devices incorporating the same channels as the in-lab standard PSG

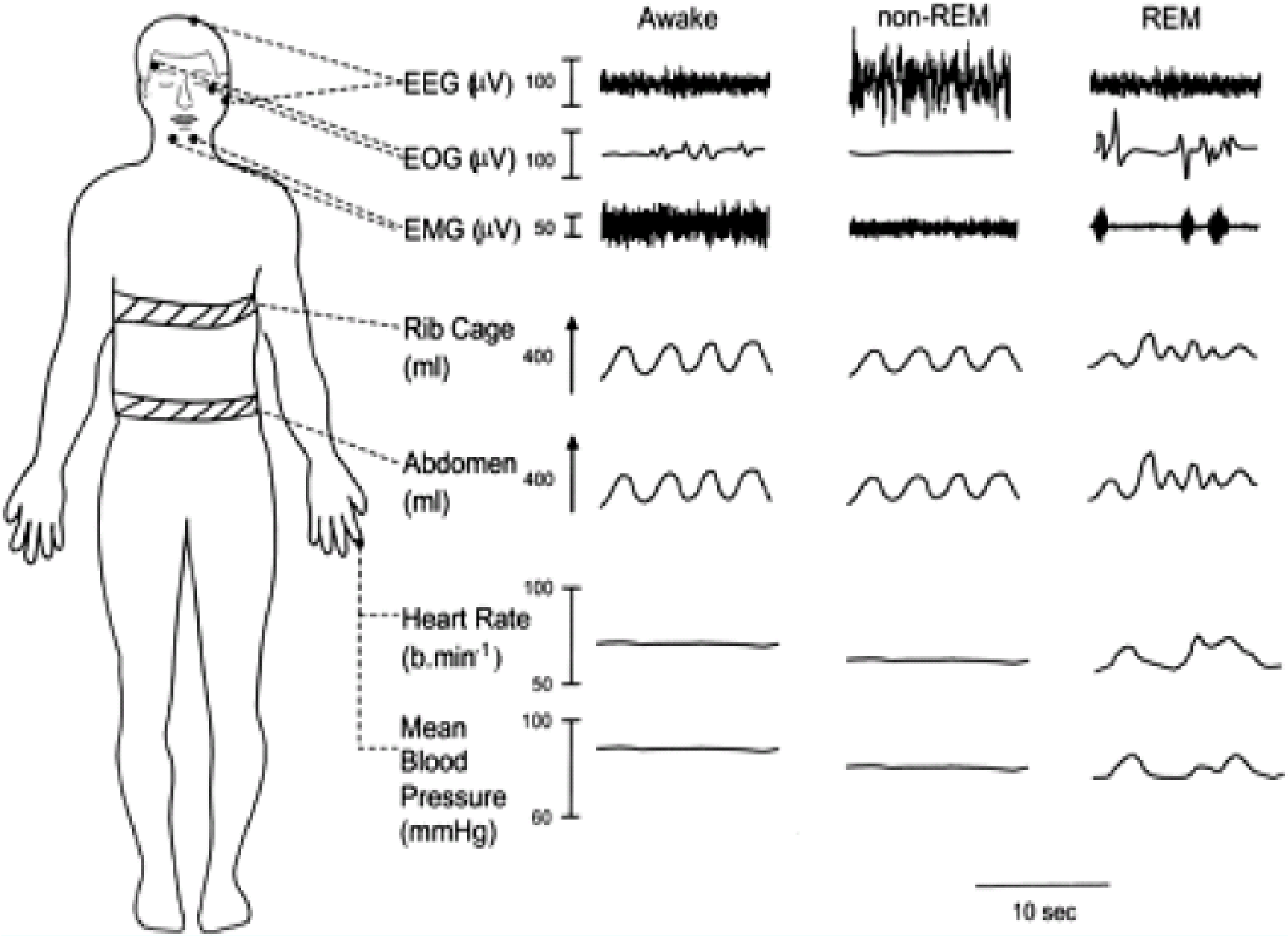
Level 3: unattended devices, which measure at least four cardio respiratory parameters

Level 4: unattended devices, recording one or two parameters

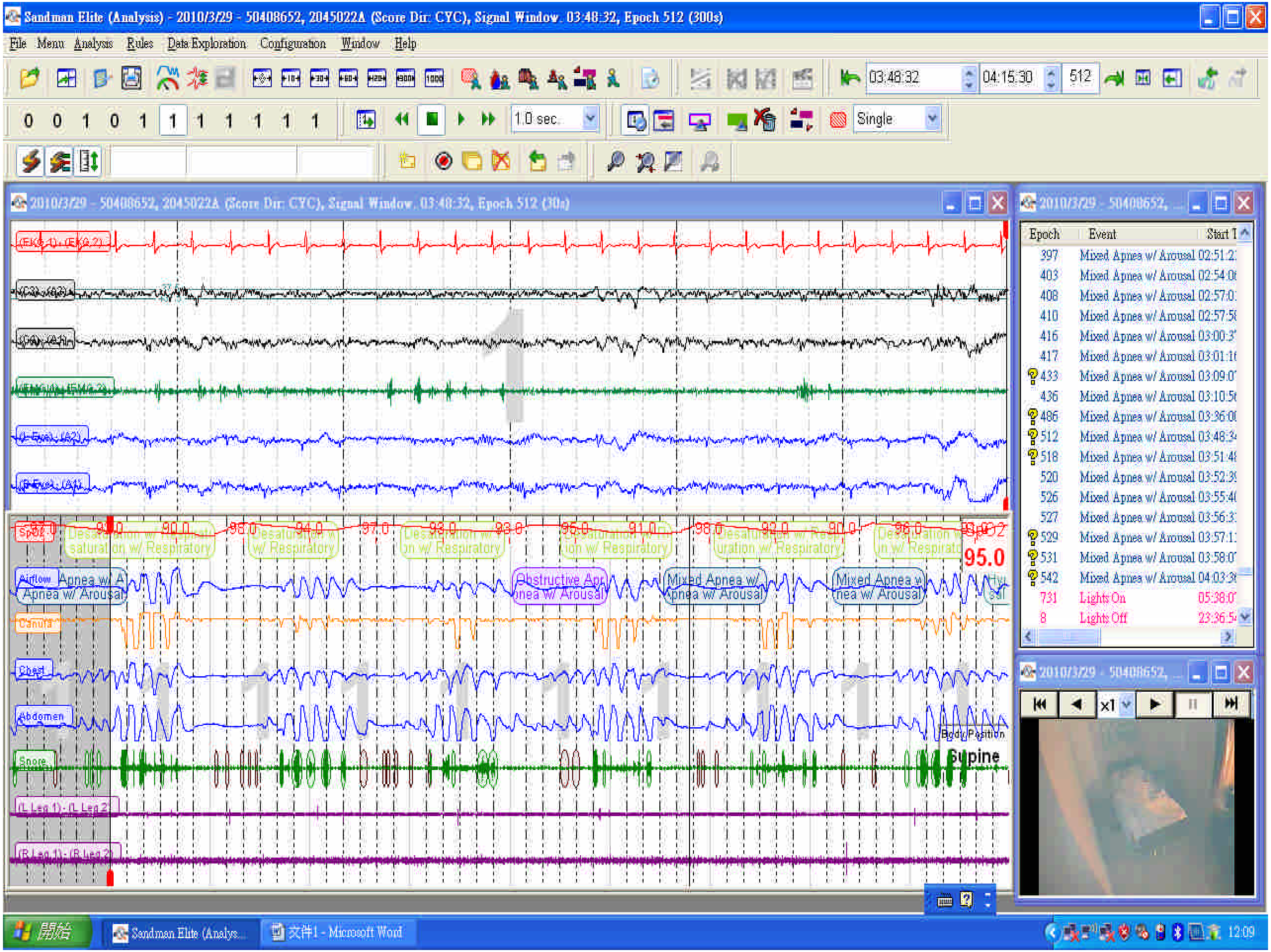
Giora Pillar, Management of Patients with Obstructive Sleep Apnea: Which Way to Go? IMAJ 2004;6:699-700



Flow Sensor
Mic
Thoracic Inductive Respiratory Band to Preamplifier Module Channel 13 Connector: 1 pin Lemo
Chest
Triple Thermistor Connector: 3 pin Lemo
External Tracheal Microphone (Internal/external switch inside PIB) Channel 15 Connector: 2 pin Lemo
Leg Sensor
Leg Sensor x2 Channels 10(L) & 11(R) Connector: 1.5 mm Touch Proof
Abdominal Inductive Respiratory Band to Preamplifier Module Channel 14 Connector: 1 pin Lemo
Abdoment
Position
Position Sensor Channel 16 Connector: 2 pin Lemo
SpO2
Gold Cup Electrodes (and/or Snap-on electrodes) Channels 1-2, 4-7 Connector: 1.5 mm Touch Proof
Auxiliary Input Examples - Channels 17-24 (17-19, 21-24 if CPAP or Nasal Airflow is in use)
Oximeter (SaO_2, $TcCO_2$)
AND/OR
Non-ISO Lead
CO_2 Monitor
ISO Lead
Temperature Probe
EEG,EOG,EMG
Patient Interface Box
Auxiliary Input Connector: BNC
pH Probe
Interface Unit (Third Party)
CPAP Monitoring Example - Channel 20
Nasal Cannula
CPAP Mask to Preamplifier Module card position 20 (typical) Connector: Tubing
Nasal Cannula to Preamplifier Module Channel 19 Connector: Tubing (diagnostic studies only)
Preamplifier Module
OR
CPAP Pump
and/or Channel 19 for Nasal Airflow



Awake
non-REM
REM
EEG (µV)
100
EOG (µV)
100
EMG (µV)
50
Rib Cage
(ml)
400
Abdomen
(ml)
400
Heart Rate
(b.min-1)
100
50
Mean
Blood
Pressure
(mmHg)
100
60
10 sec



Sandman Elite (Analysis) - 2010/3/29 - 50408652, 2045022A (Score Dir: CYC), Signal Window. 03:48:32, Epoch 512 (300s)
File Menu Analysis Rules Data Exploration Configuration Window Help
03:48:32
04:15:30
512
1.0 sec.
Single
2010/3/29 - 50408652, 2045022A (Score Dir: CYC), Signal Window. 03:48:32, Epoch 512 (30s)
Epoch Event Start T
397 Mixed Apnea w/ Arousal
403 Mixed Apnea w/ Arousal
408 Mixed Apnea w/ Arousal
410 Mixed Apnea w/ Arousal
416 Mixed Apnea w/ Arousal
417 Mixed Apnea w/ Arousal
433 Mixed Apnea w/ Arousal
436 Mixed Apnea w/ Arousal
486 Mixed Apnea w/ Arousal
512 Mixed Apnea w/ Arousal
518 Mixed Apnea w/ Arousal
520 Mixed Apnea w/ Arousal
526 Mixed Apnea w/ Arousal
527 Mixed Apnea w/ Arousal
529 Mixed Apnea w/ Arousal
531 Mixed Apnea w/ Arousal
542 Mixed Apnea w/ Arousal
731 Lights On 05:38:0
8 Lights Off 23:36:5
SpO2
95.0
Airflow
Apnea w/ Arousal
Obstructive Apnea w/ Arousal
Mixed Apnea w/ Arousal
Canula
Chest
Abdomen
Snore
Body Position
Supine
開始
Sandman Elite (Analys...
文件1 - Microsoft Word
12:09

Polysomnography and the Signals Measurement (6/17)

Sleep – Variables Evaluated

Sleep staging
- Wake, NREM (1,2,3), REM
- Arousals

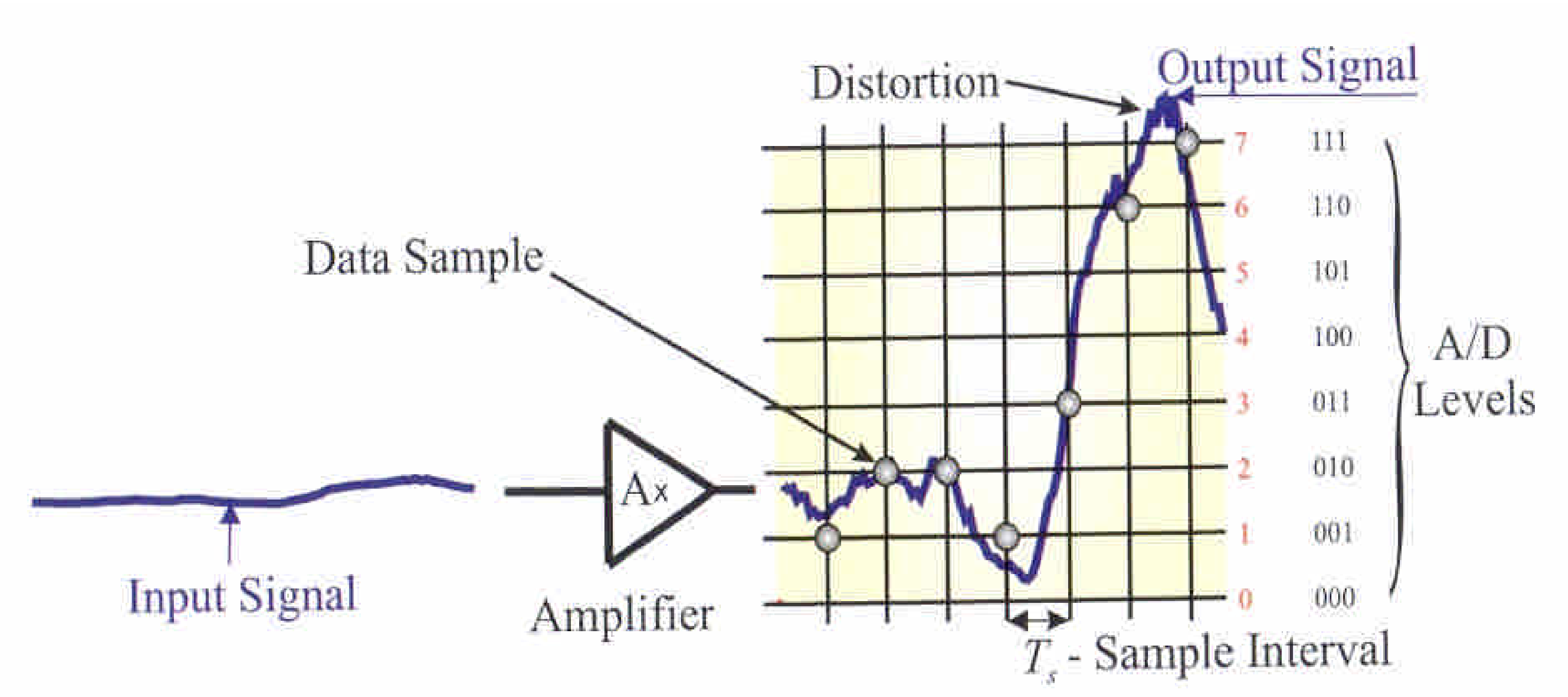
Respiratory
- Apneas and hypopneas
- Upper airway resistance
- RERA

Limb EMG
- PLMS
- Restless legs

(all of the above, grouped by a brace:) Polysomnography (PSG)

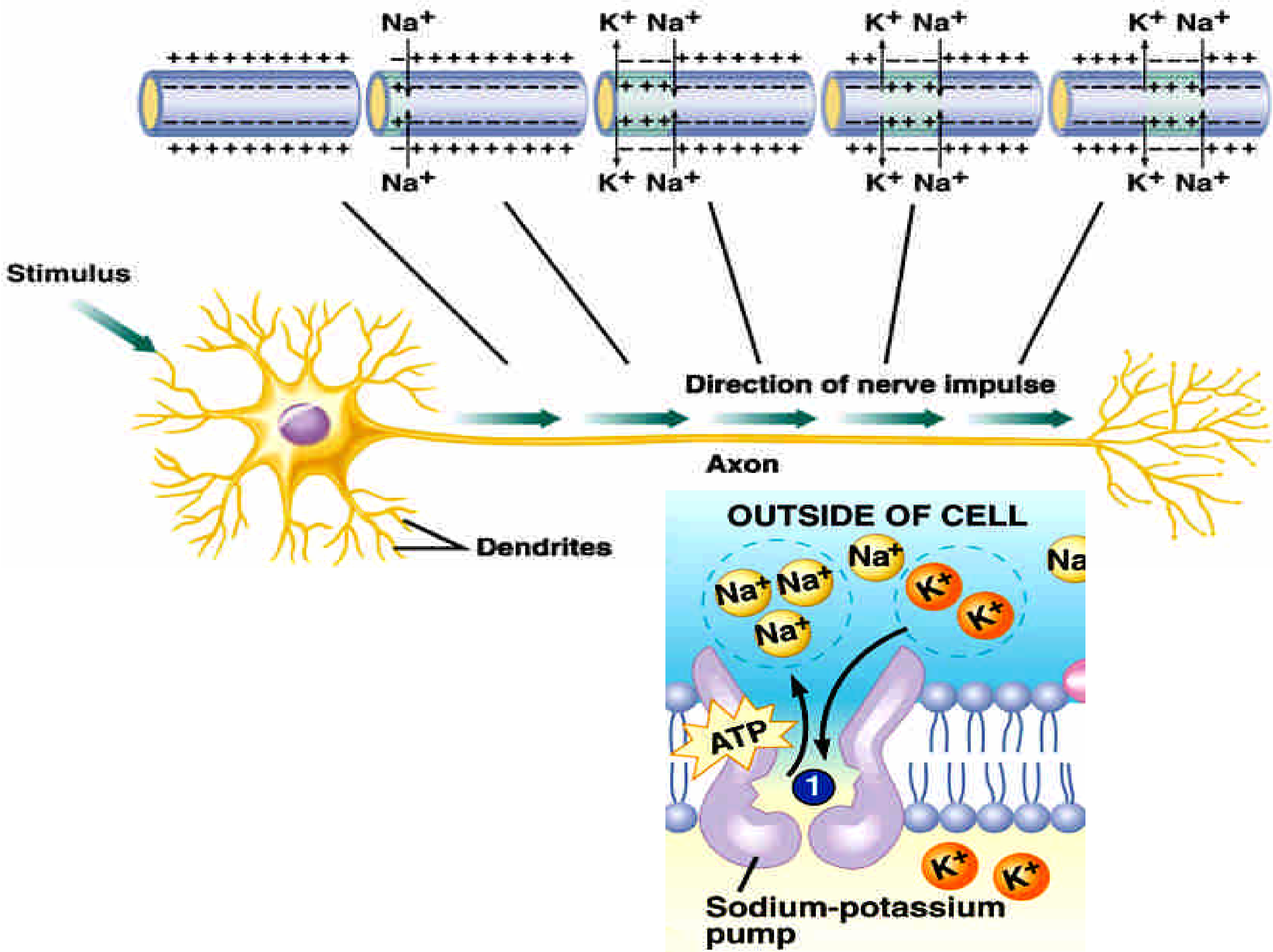
Optimal Pressure (CPAP)

SOREM + SL (MSLT)

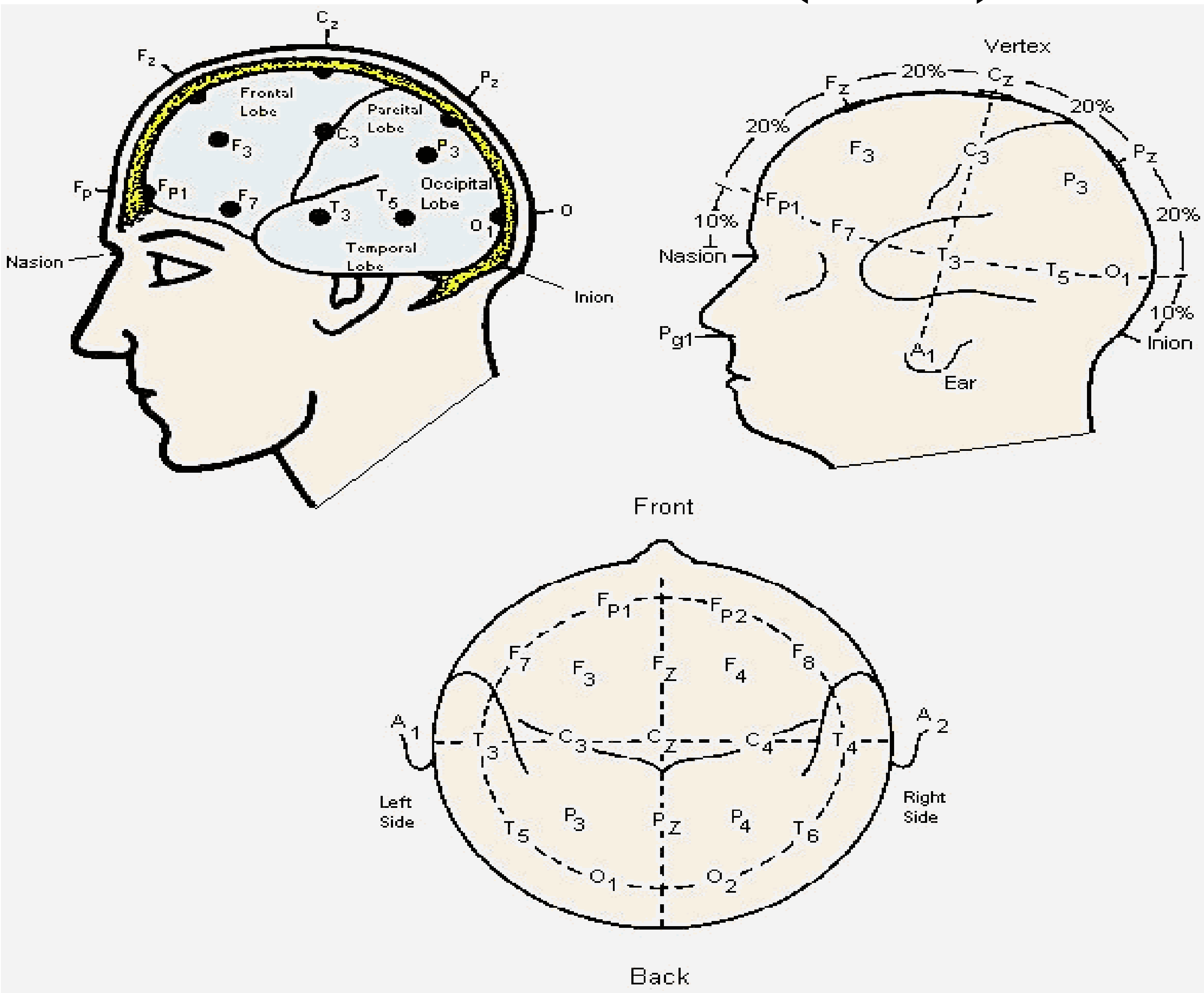


ADC:3bits, 2^3=8 levels of conversion.

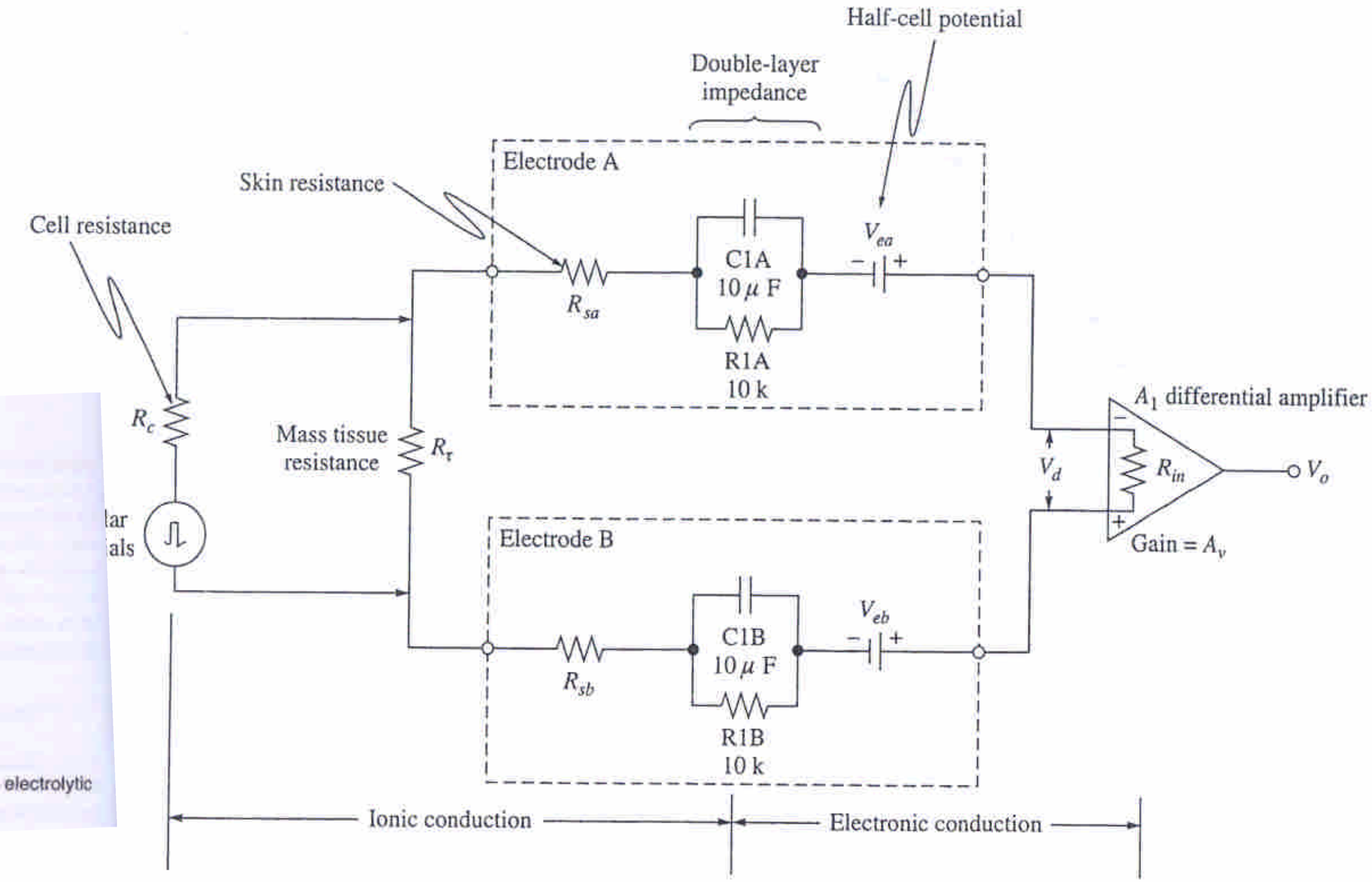
Wim van drongelen. Signal prosessing for neuroscientists.2008


Na+
K+ Na+
Stimulus
Direction of nerve impulse
Axon
Dendrites
OUTSIDE OF CELL
Na+
K+
ATP
1
Sodium-potassium pump

Polysomnography and the Signals Measurement (9/17)



EEG



(a)

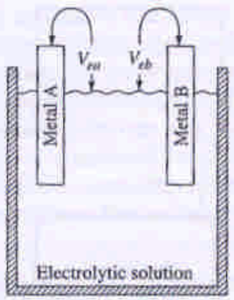
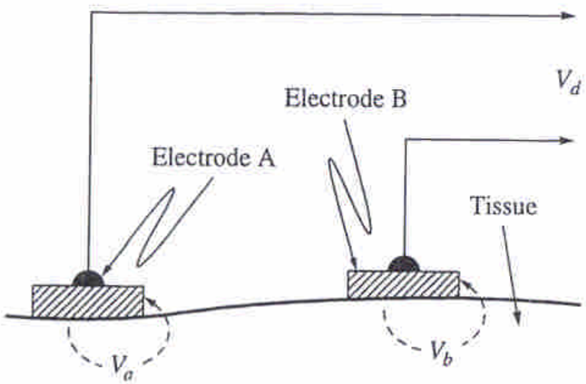


Figure 6-12
Dissimilar metals immersed in a common electrolytic solution produce differential potentials.



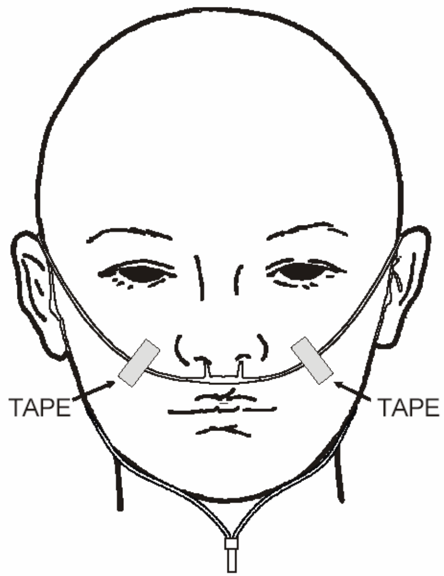
Joseph J. Carr and John M. Brown. Introduction to Biomedical Equipment Technology.2000.

Polysomnography and the Signals Measurement (11/17)

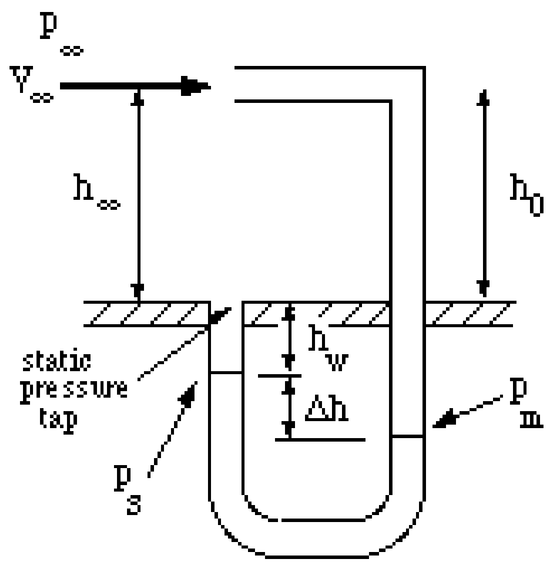
- Respiratory:

Thermistors/ Thermocouples/

Nasal Cannula



The Pitot Tube



- **電阻式感測器RTD（ResistanceTemperature Detector）：**

  特殊的導線或薄膜，是利用材料的電阻會隨著溫度的變化而改變的特性，一般常用的金屬材料有Pt 、 Ni 、 Cu

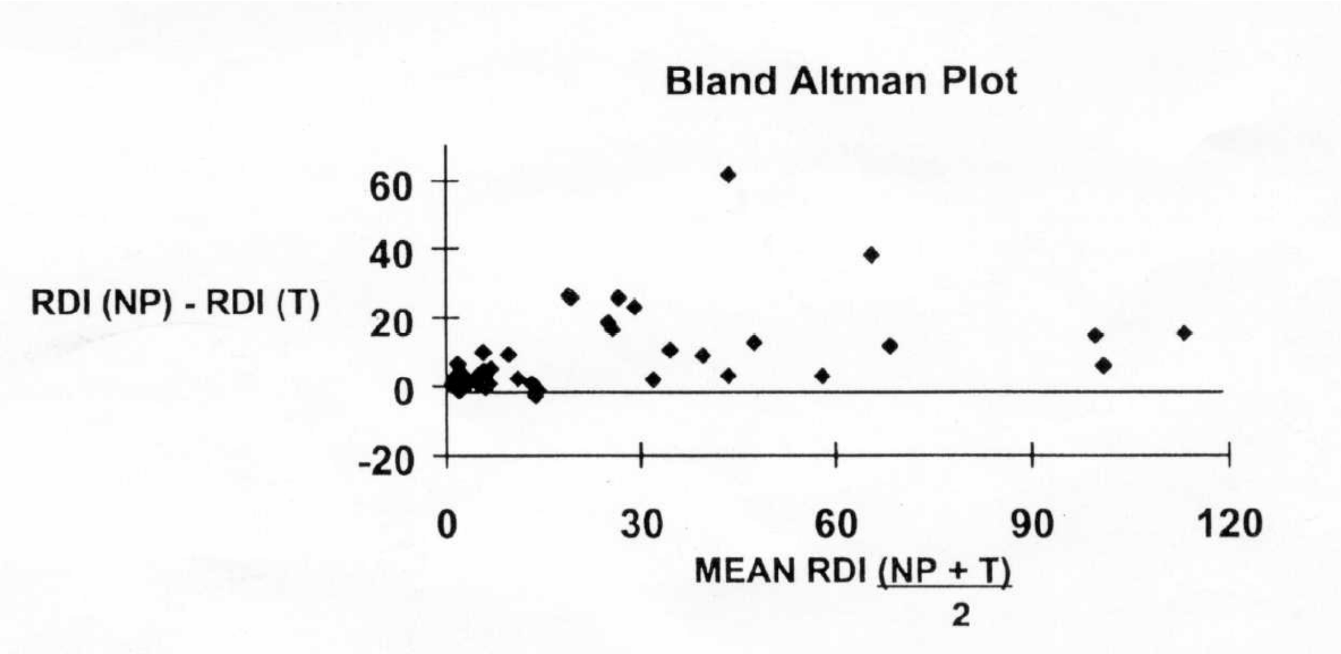
- **熱敏電阻（Thermistor）:**利用陶瓷半導體材料的電阻,隨著溫度的變化而改變的特性

- **熱電偶（Thermocouple）**兩種不同材料的金屬一端接合後，在不同的溫度下另一端會產生不同的電壓

	熱電偶 (Thermocuple)	電阻式溫度感測器 (RTD)	熱敏電阻 (Thermistor)
準確度	良好（約 1～10°F）	極佳（0.01～1°F）	佳（0.1～1°F）
穩定性	最不穩定	最穩定	良好
範　圍	很寬 (-270～2300℃)	尚可 (-200～700℃)	很小 (-80～250℃)
價　格	不貴	昂貴	
優　點	堅固耐用 量測溫度範圍廣 反應快／互換性佳	最準確 可量測範圍準確度高 互換性佳	反應快 最靈敏 兩線式
缺　點	低電壓 最不靈敏 需冷端補償	會自加熱 需要三或四線式 反應慢	會自加熱/量測溫度範圍小 脆弱 互換性不佳

Polysomnography and the Signals Measurement (13/17)

- Study shows that RDI is at least 5 to 25 events per hour higher with Nasal Pressure



- COMPARISON OF NASAL PRESSURE AND THERMISTOR RECORDINGS IN THE DETECTION OF SLEEP-DISORDERED BREATHING EVENTS, Cunninham SL, Shea SA, White DP; SLEEP Vol. 21, Supplement, pp 62

Polysomnography and the Signals Measurement (14/17)

- Chest /Abdomen movement

Strain Gauges: V= IR

lower cost

Inductance Plethysmography (RIP):f. oscillators

truest measure: UARS

Stephen Lund and Jon Freeman.Clinical Polysomnography. In:Sleep apnea and snoring.2009.

Polysomnography and the Signals Measurement (15/17)

SpO_2

Spectrophotometer:Beer-Lam-bert law

I out= I in ^ exp –(DC ε)

I out: intensity of light out of sample

I in: intensity goes into the sample

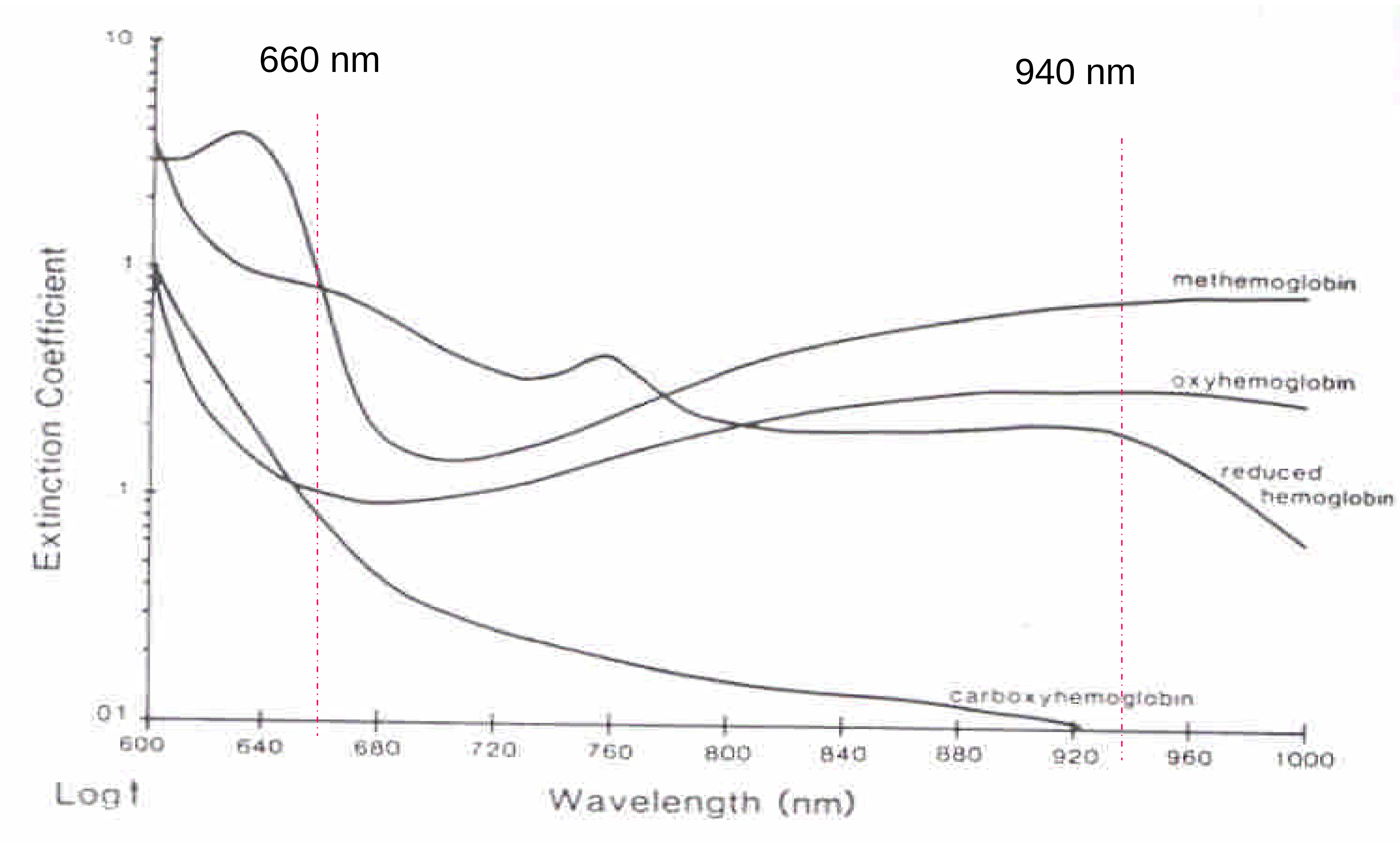
D: distance, light travels

C: [Hb]

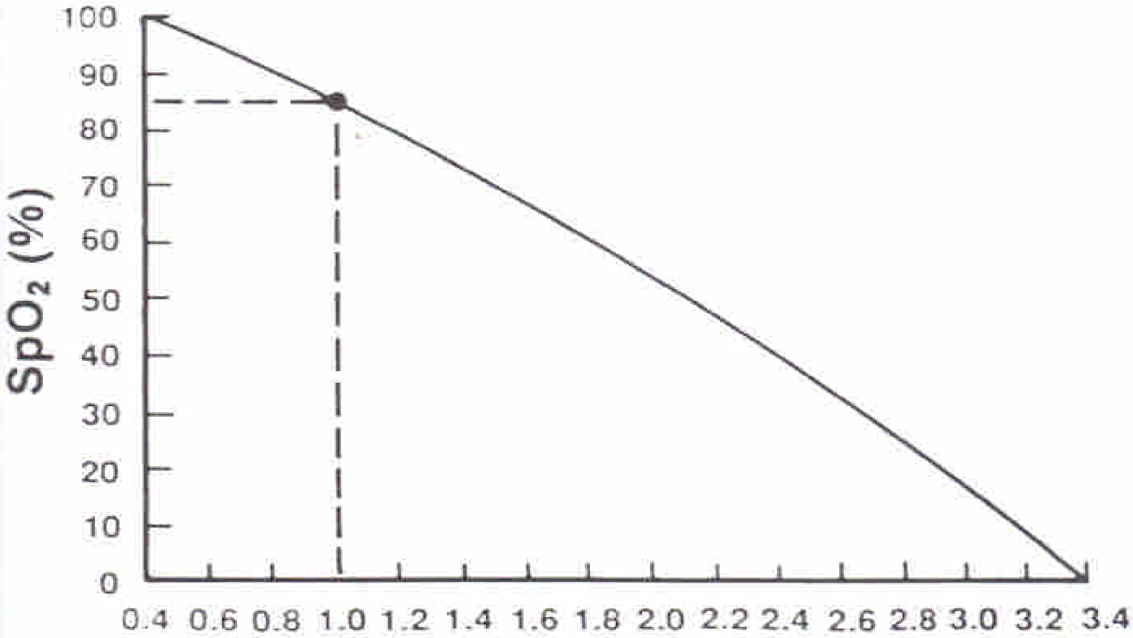
ε : extinction coefficient

Martin J. Tobin. Respiratory monitoring.1991.pp79-100

Polysomnography and the Signals Measurement (16/17)



Polysomnography and the Signals Measurement (17/17)



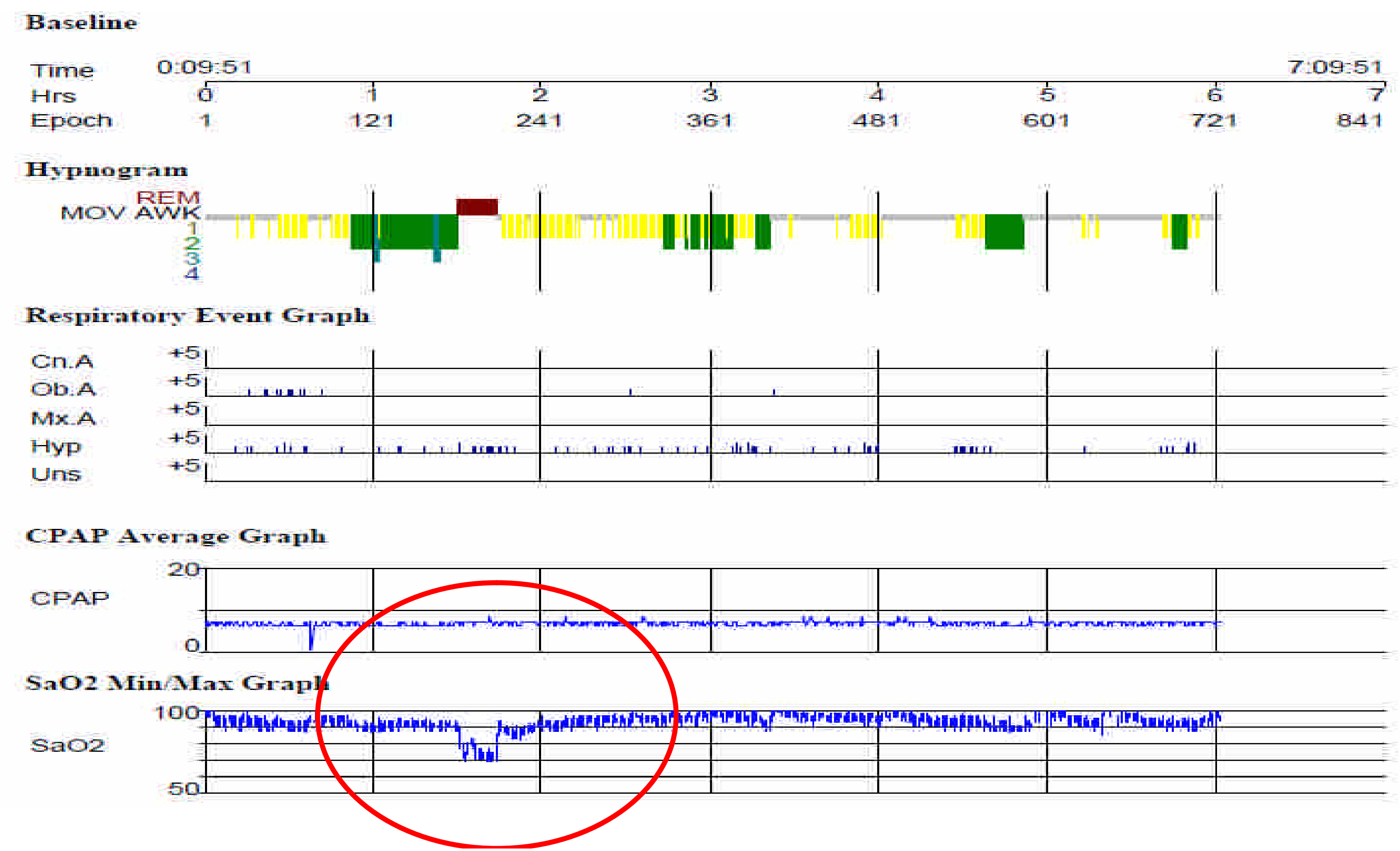
$$R = \frac{AC_{660}/DC_{660}}{AC_{940}/DC_{940}}$$

FIGURE 3 A typical pulse oximeter calibration curve. The S_aO_2 estimate is determined from the ratio (R) of the pulse-added red absorbance at 660 nm to pulse-added infrared absorbance at 940 nm. From Tremper KK, Barker SJ: Pulse oximetry. Anesthesiology 70:98, 1989. With permission.

The S_aO_2 estimate is determined from the ratio of the pulse-added red absorbance at 660 nm to pulse-added infrared absorbance at 940 nm.

Bias: < 80 %, - 5% to 5%

< 63 %. -12 % to 18 %



Interesting Studies (1/6)

How sleep affects the developmental learning of bird song

Sébastien Derégnaucourt[1], Partha P. Mitra[2], Olga Fehér[1], Carolyn Pytte[3] & Ofer Tchernichovski[1]

[1]*Department of Biology, City College, City University of New York, New York 10031, USA*
[2]*Cold Spring Harbor Laboratory, Cold Spring Harbor, New York 11724, USA*
[3]*Department of Biology, Wesleyan University, Middletown, Connecticut 06459, USA*

Sleep affects learning and development in humans and other animals, but the role of sleep in developmental learning has never been examined. Here we show the effects of night-sleep on song development in the zebra finch by recording and analysing the entire song ontogeny. During periods of rapid learning we observed a pronounced deterioration in song structure after night-sleep. The song regained structure after intense morning singing. Daily improvement in similarity to the tutored song occurred during the late phase of this morning recovery; little further improvement occurred thereafter. Furthermore, birds that showed stronger post-sleep deterioration during development achieved a better final imitation. The effect diminished with age. Our experiments showed that these oscillations were not a result of sleep inertia or lack of practice, indicating the possible involvement of an active process, perhaps neural song-replay during sleep. We suggest that these oscillations correspond to competing demands of plasticity and consolidation during learning, creating repeated opportunities to reshape previously learned motor skills.

Interesting Studies (2/6)

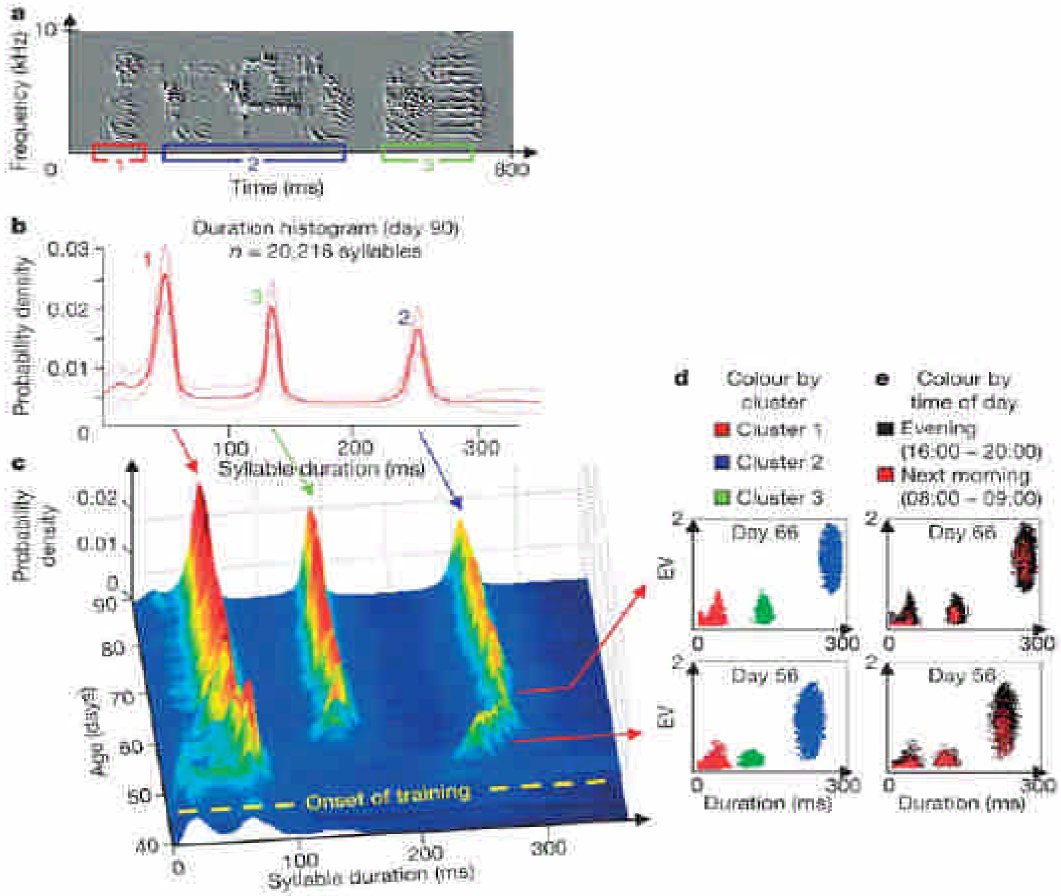


Figure 1 Tracing vocal changes. **a**, Spectral derivatives[29] of adult song motif with three syllables. **b**, Smoothed histogram of syllable durations[46] in an adult bird (±95% confidence interval). Each peak corresponds to a song-syllable type of distinct duration. **c**, To trace the development of syllable types we plot developmental maps in which each row represents the duration histogram of syllables during one day. Syllable types (ridges) emerged shortly after training. **d**, Plotting two-dimensional distribution (duration versus Wiener EV) shows syllable types as clusters (unclustered syllables are not shown). Changes in the position of clusters reveal vocal changes. **e**, Colour-coding circadian time shows vocal changes after night-sleep.

Interesting Studies (3/6)

Proceedings of the 2009 IEEE International Conference on Systems, Man, and Cybernetics
San Antonio, TX, USA - October 2009

The Design of Wireless Sleep EEG Measurement System With Asynchronous Pervasive Sensing

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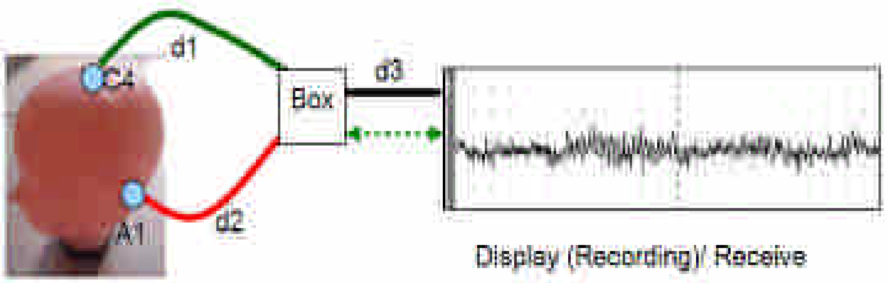


Fig. 1. Overview of a standard wire/wireless EEG system, where the Box consists of a preamplifier and a filter.

In a standard wire/wireless sleep EEG system, by having

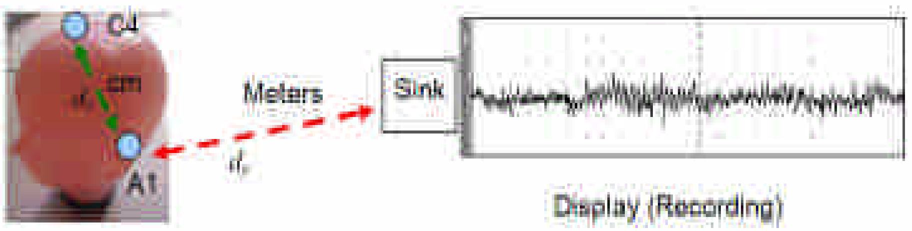


Fig. 3. The architecture of the proposed sleep EEG system.

Interesting Studies (4/6)

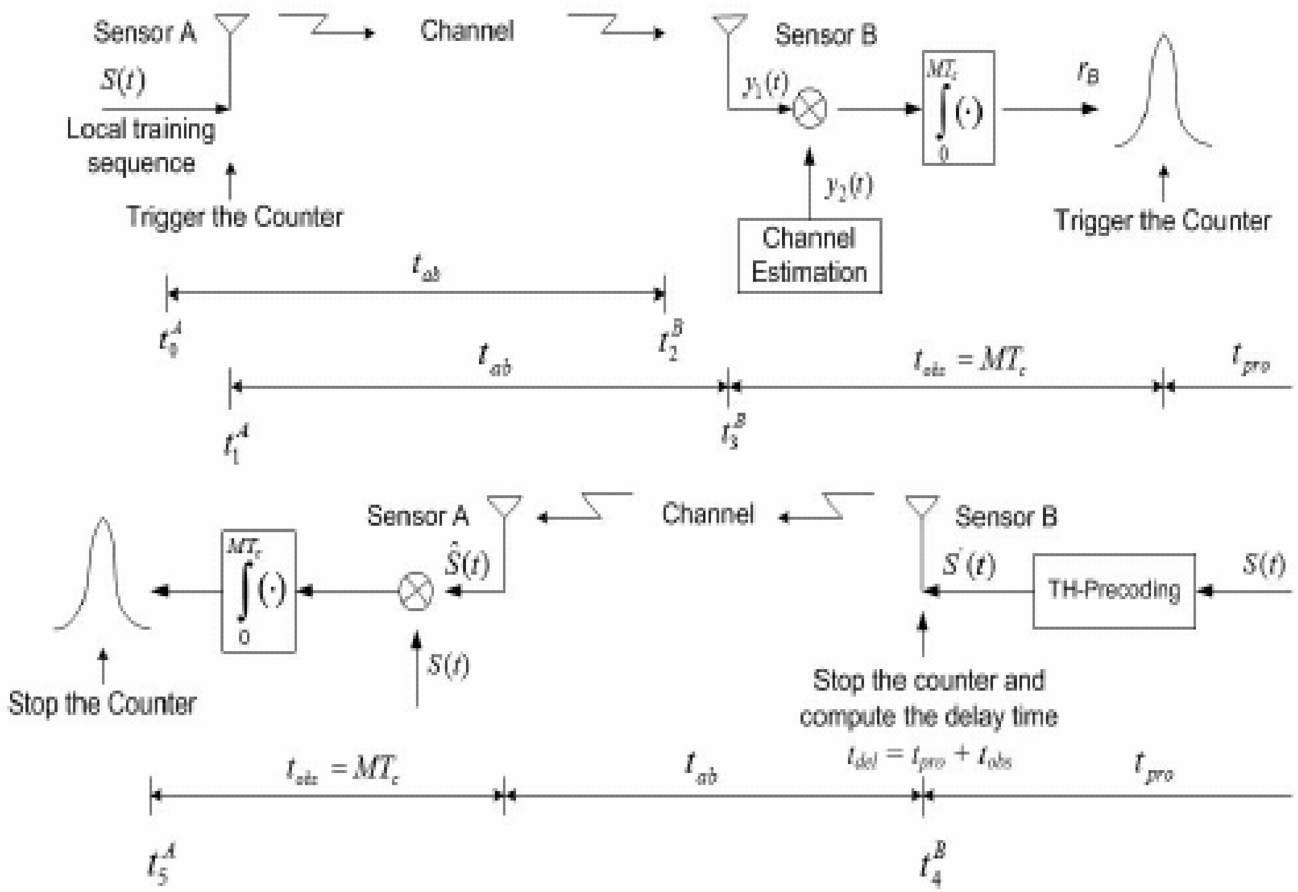


Fig. 5. Block diagram of a bidirectional communication and time measurement system using channel estimation and TH precoding.

***Asynchronous Pervasive Sensing Algorithm* (APSA)**

(I) Time Synchronization and Signal Collection and (II) EEG Signal Segmentation.

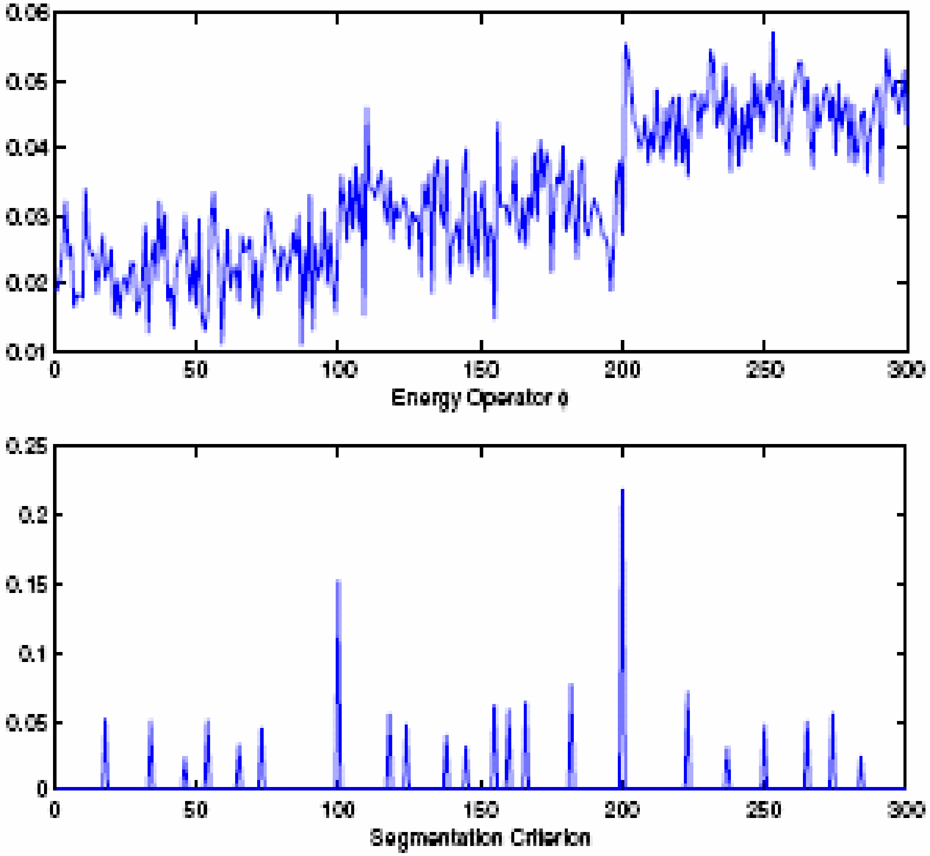


Fig. 17. Simulation example of segmentation of two channels with TH precoding and the measurement noise $\sigma_w = 0.05$.

4368 • The Journal of Neuroscience, April 23, 2008 • 28(17):4368–4376

Interesting Studies (5/6)

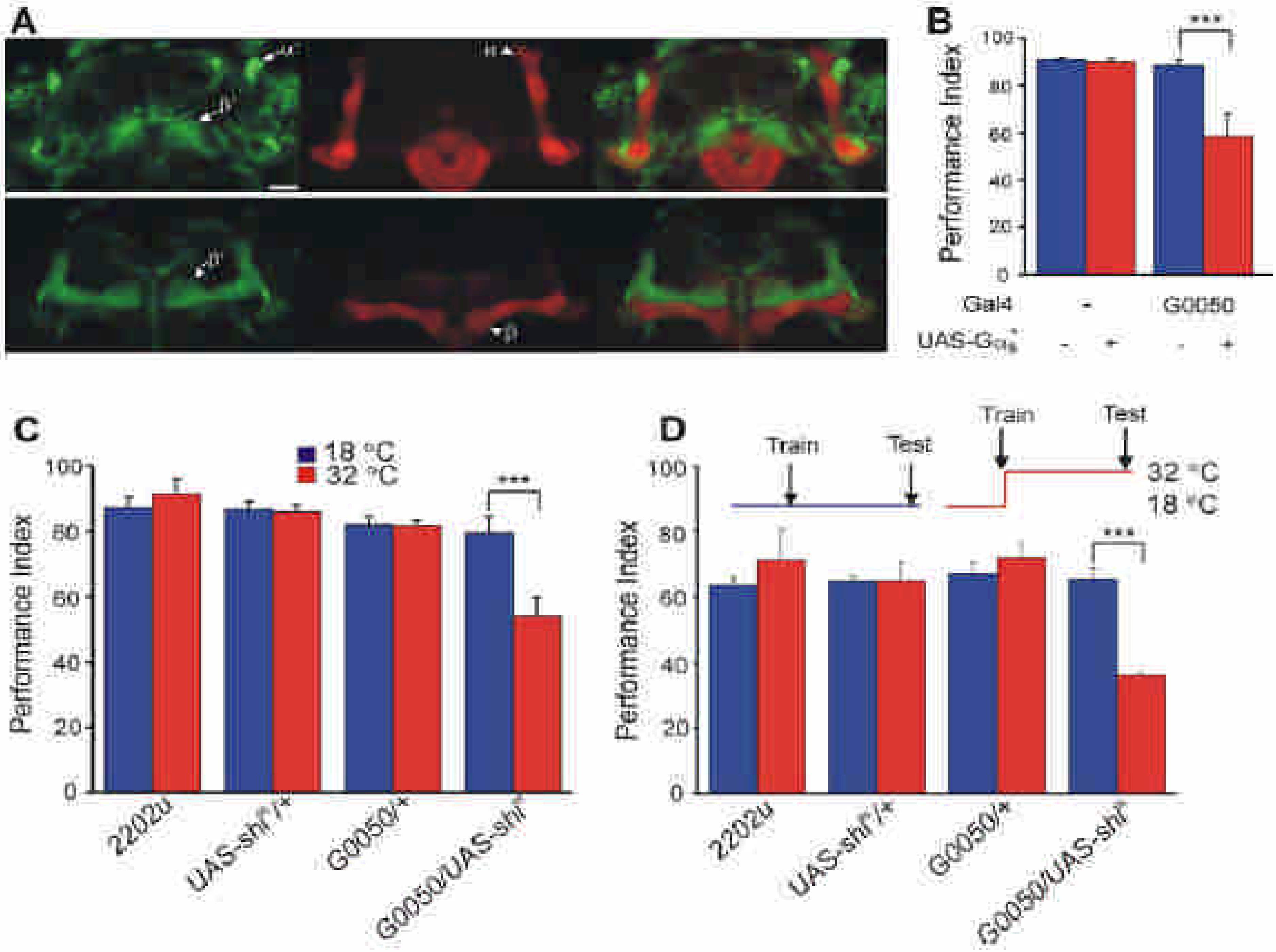
Behavioral/Systems/Cognitive

Imaging of an Early Memory Trace in the *Drosophila* Mushroom Body

Yalin Wang,[1]* Akira Mamiya,[1]* Ann-shyn Chiang,[2] and Yi Zhong[1]
[1]Cold Spring Harbor Laboratory, Cold Spring Harbor, New York 11724, and [2]Institute of Biotechnology, National Tsing Hua University, Hsinchu 30043, Taiwan, Republic of China

Extensive molecular, genetic, and anatomical analyses have suggested that olfactory memory is stored in the mushroom body (MB), a higher-order olfactory center in the insect brain. The MB comprises three subtypes of neurons with axons that extend into different lobes. A recent functional imaging study has revealed a long-term memory trace manifested as an increase in the Ca^{2+} activity in an axonal branch of a subtype of MB neurons. However, early memory traces in the MB remain elusive. We report here learning-induced changes in Ca^{2+} activities during early memory formation in a different subtype of MB neurons. We used three independent *in vivo* and *in vitro* preparations, and all of them showed that Ca^{2+} activities in the axonal branches of α'/β' neurons in response to a conditioned olfactory stimulus became larger compared with one that was not conditioned. The changes were dependent on proper G-protein signaling in the MB. The importance of these changes in the Ca^{2+} activity of α'/β' neurons during early memory formation was further tested behaviorally by disrupting G-protein signaling in these neurons or blocking their synaptic outputs during the learning and memory process. Our results suggest that increased Ca^{2+} activity in response to a conditioned olfactory stimulus may be a neural correlate of early memory in the MB.

Key words: learning and memory; *Drosophila*; imaging; calcium; olfactory; fluorescence microscopy


A
B
Performance Index
Gal4
G0050
UAS-Gαs*
***
C
18 °C
32 °C
Performance Index
2202u
UAS-shi^{ts}/+
G0050/+
G0050/UAS-shi^{ts}
***
D
Train
Test
32 °C
18 °C
Performance Index
2202u
UAS-shi^{ts}/+
G0050/+
G0050/UAS-shi^{ts}
***

Interesting Studies (6/6)

動物用微型無線多功能生理訊號發射器 Multiple Miniature Wireless Apparatus for Recording Physiological Signals of Rats

Sleep 國立陽明大學睡眠研究中心

功能：連續記錄動物心電、腦電及肌電記錄或由無線傳輸至遠端分析電腦進行分析

規格：

心電圖
1. 放大倍率：538
2. 濾波範圍：1.6-113 Hz
3. 解析：8-12位元
4. 取樣率：500 Hz

肌電圖
1. 放大倍率：1000
2. 濾波範圍：16-113 Hz
3. 解析：8-12位元
4. 取樣率：500 Hz

腦電圖
1. 放大倍率：1000
2. 濾波範圍：0.34-53 Hz
3. 解析：8-12位元
4. 取樣率：500 Hz

無線界面
1. 無線發射頻道：2.4GHz-2.5GHz
2. 無線電發射功率：10uW-1mW
3. 傳輸距離：2-50M

應用範圍：
1. 動物用無線生理紀錄系統

- 度航空客機失事或因飛行員疲勞過度打瞌睡　　**2010.05.24** 2010-05-23 環球網 記者譚利婭
- 據臺灣“中央社”5月23日報導，印度卡納塔卡邦的芒格洛爾機場市發生嚴重空難。失事飛機執行的是快速返航的夜航任務，有媒體報導稱，飛行員疲勞駕駛可能導致災難性的後果。　《印度時報》23日以“飛行員們只想睡覺”爲題，報導夜航造成機組人員精神和心理負擔增加，可能產生災難性的後果。印度民航飛行員協會的資料顯示，78%的空難原因都是人爲錯誤，其中絕大部分是飛行員疲勞造成的。

睡眠不足發炎指數高 心臟病風險卡多

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睡眠不足，身體容易發炎？美國艾默理大學醫學院研究發現，睡眠不足的人身體發炎指數比較高，身體較容易發炎，進而增加心臟病、中風風險。

這項研究發表於美國心臟協會科學研討會。研究團隊以問卷調查了解525位中年民眾睡眠狀況，包括睡眠品質、睡眠時間長短等，然後再比對三項發炎指標，包括纖維蛋白原、白細胞介素-6與C-反應蛋白等，結果顯示，睡眠不夠、睡眠時間少於六小時的人，體內發炎指數偏高。

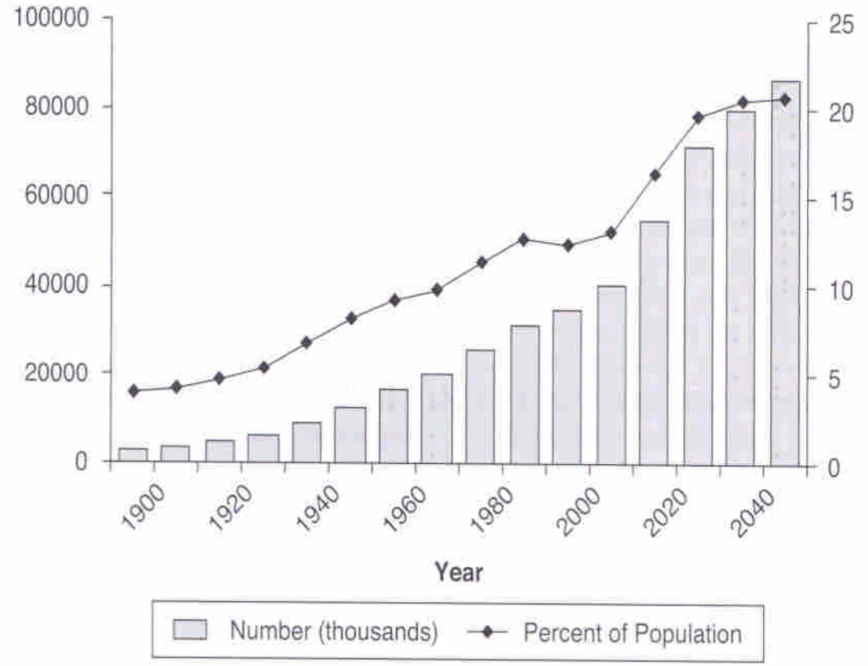
研究人員解釋，急性睡眠不足、睡眠剝奪會導致體內發炎荷爾蒙增多，血管功能也隨之改變。研究發現，和睡眠時間達6到9小時的人相比，睡眠時間少於六小時的人發炎指標C-反應蛋白較高，多出約百分之二十五。即使抽菸、血壓、糖尿病、肥胖等因素都納入考量，結果還是一樣。身體中的C-反應蛋白居高不下的話，心臟病風險增加約一倍，中風機率也會上升。

過去研究發現，晚上睡眠時間在7、8小時的人活得比較久。而睡眠時間太長、太短和高血壓、肥胖、糖尿病和心理壓力有關，這些因素也都會影響心臟病、中風風險。

Table 1.2 Current state of evidence for an association between sociodemographic factors and sleep problems or sleep disorders

	High risk sleep duration[a]	*Sleep apnea*	*Insomnia*
Gender	Yes	Yes	Yes
Race	Yes	?	?
Education	Yes	Yes	Yes
Marital status	Yes	?	?
Age	Yes	Yes	Yes

[a]Either short or long sleeping.



Population growth of older Americans (≥65 years). Source: Federal Interagency Forum
ited Statistics, 2004

Table 5.1 Prevalences of sleep problems in the elderly

Chronic sleep problem	*Prevalence (%)*
Any sleep complaint	57
Sleep apnea	24
PLMS[a]	45
Insomnia	29
Early morning awakening	19

Foley et al.[2]; Ancoli-Israel et al.[37]
[a]Periodic limb movements in sleep.

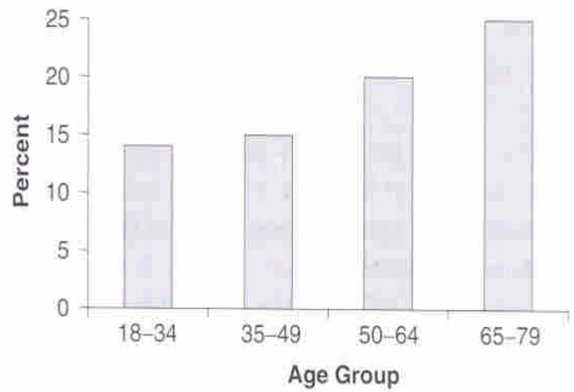


Figure 5.2 Prevalence of insomnia by age group. Source: Mellinger et al.[38]; Foley et al.[2]

What may we do more in the future?

Do some different based on the basic knowledge

Thank you

莎士比亞(Shakespeare) :
睡眠是每一天的小死亡，
是創傷心靈的良藥，
是生命中最豐富的筵席，
而有人認爲它是被囚者的自由，
是人生中最歡樂的事。