

Physiology of Consciousness

علق عليه: عبدالرحمن بن توفيق خوجة
عفا الله عنه ونفع به

-اللهم بارك-

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Brain Activity States

- -- Q: What are "states" (in terms of function) in which brain activity can be?
- (1) Normal Consciousness
(state of normal arousal , being fully awake and aware of the self and surroundings)
- (2) Clouded consciousness: مشوش person conscious but mentally confused (e.g., in cases of drug or alcohol intoxication, **high fever** associated with **malaria** or septicemia, dementia, etc.).
- (3) Sleep: person unconscious (in relation to the external world & surroundings), but is **arousable** (can be aroused).
- (4) Coma: person unconscious and not arousable. قد تكون عيناه مفتحتان.

ثم الميت دماغيا.. لا تخطيط هنالك

What is Consciousness?

- Therefore, consciousness is the brain state in which a person is being aware of the self **and** surroundings.
- It is a product of **electrical activity** of the brain
- (A person with a flat EEG **cannot** be conscious! وإذا كان الجهاز خربان

(:)

- Consciousness depends upon interactions between →
- (1) Reticular Formation (RF).
- (2) Thalamus
- (3) Cortical Association areas.

References:

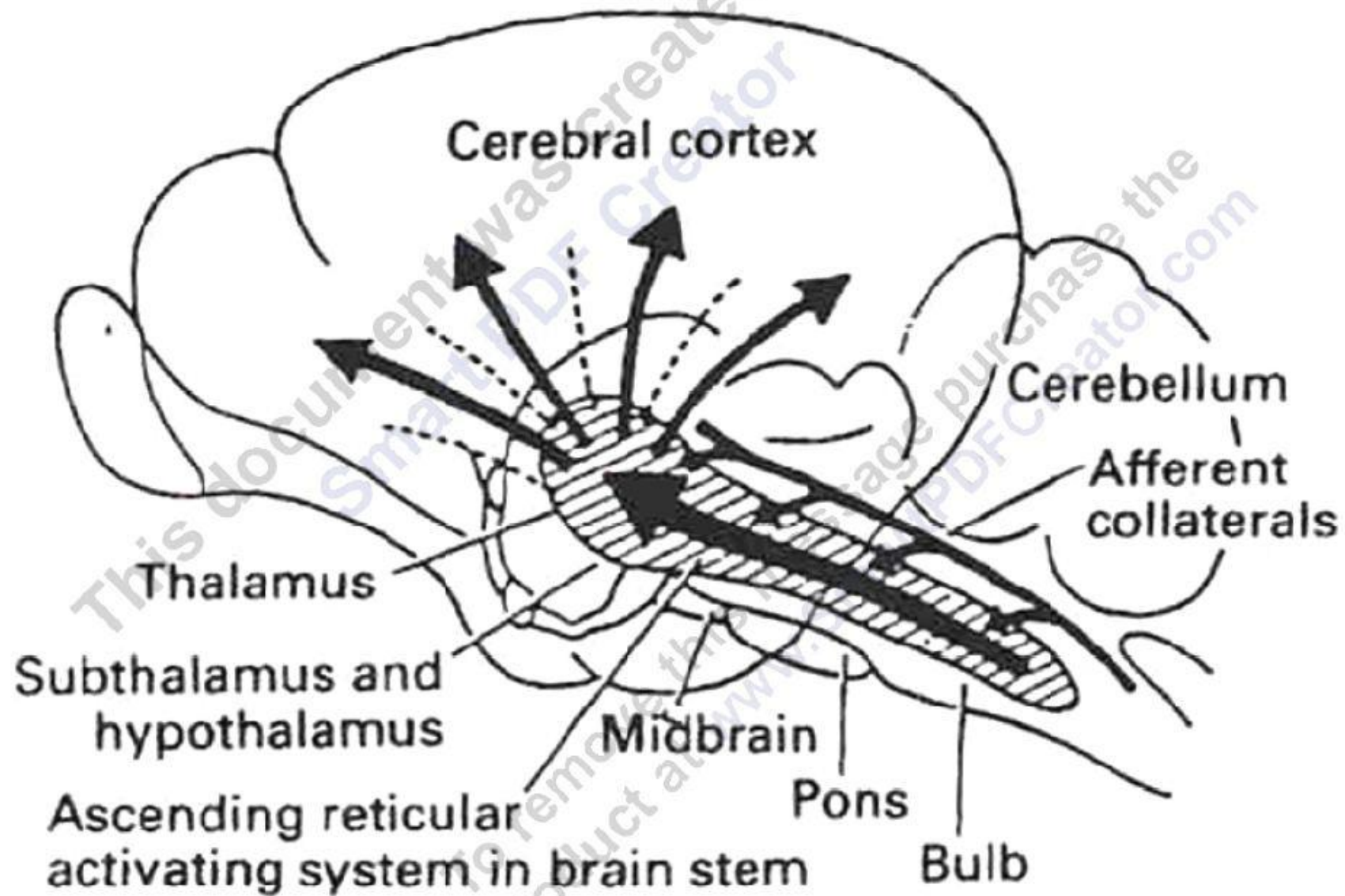
- (1) Ganong & Guyton Textbooks of Medical Physiology (2) Blumenfeld H , The Neuroscientist 2005 (3) Kostopoulos GK . Epilepsia 2001; 42 :13-19
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Reticular Activating System (RAS)

(Bulboreticular Facilitory Area + Thalamus)

- * In 1945, the Italian neurophysiologist Moruzzi and his colleagues found that a lesion in the **mid-pons** makes the animal spend the rest of its life unconscious. ستتكرر في محاضرة النوم
- * They concluded that the areas in the upper pons **and** midbrain المولدات الكهربائية are essential for wakefulness, and called it the Bulboreticular Facilitory (Excitatory) Area of the reticular formation. هي بإذن الله تصحي الثالاموس والثالاموس بدوره يصحي الكورتكس
- * (This Bulboreticular Facilitory Area is also called by some scientists The Brainstem Ascending Reticular Activating System).
- * The Bulboreticular Facilitory (Excitatory) Area sends excitatory signals into Thalamus. As a result, the thalamus excites almost all areas of the cortex.
- * The Bulboreticular Facilitory (Excitatory) Area + Thalamus together constitute the Reticular Activating System (RAS).
- * The RAS is the system which keeps our cortex awake and conscious.

RAS



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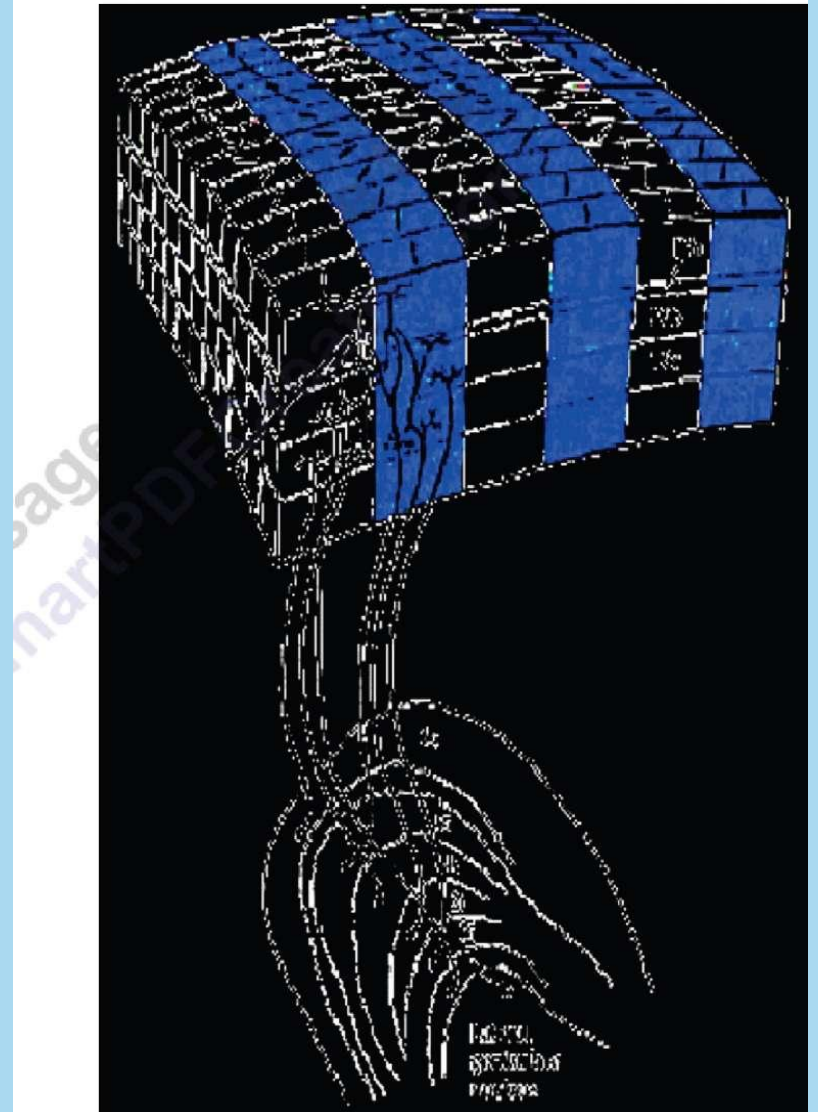
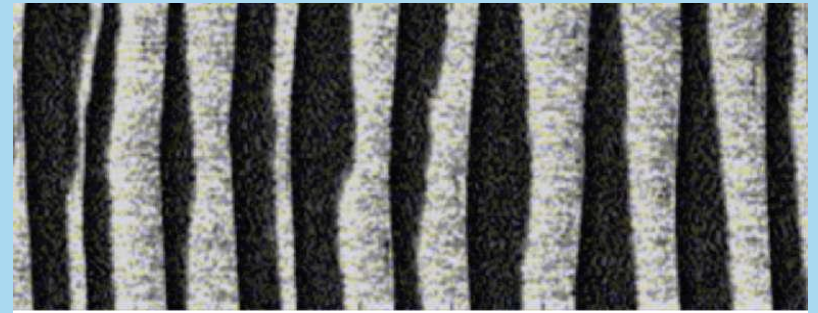
- The awakening action of the RAS is mediated **by** fibers secreting Acetylcholine (ACh) and Norepinephrine (NE)
- The RAS provides the **main** drive that maintains effective cortical excitability level, & interruption of this ascending pathway (e.g., by a tumor or hemorrhage) causes the subject to go into coma.
- The level of consciousness is largely influenced by :
 - (1) peripheral sensory inputs **كالمغص مثلا**, and by
 - (2) Thalamocortical sectors.

مثلا النشادر يصحي عن طريق الشم.. بالنشادر.. التراييمينال متحسس للنشادر عن طريق الجلد في الأنف وكالحديث الممل.

Peripheral Sensory Inputs Increase the Level of Excitation of the Bulboreticular Facilitatory Area:

- The level of activity of the Bulboreticular Facilitatory Area and, consequently, the level of alertness and arousal is largely determined by the number and type of sensory (afferent) signals that enter the CNS from the periphery.
- Pain signals, in particular, increase activity in this excitatory area and therefore strongly excite the brain to attention.
 - Role of Thalamo-Cortical Sectors:
- Not only do excitatory signals pass to the cerebral cortex from the RAS, but **feedback** signals سواء أثر راجع محفز أم مثبط also return from the cortex back to the Thalamus (which is part of the RAS).

- Almost every area of the cerebral cortex connects with its own highly specific area in the thalamus.
- These functional segments are called Thalamocortical Sectors
- They are *made of* -> Thalamo-cortical (TC) fibers and feedback Corticothalamic (CT) fibers.
- These neural *circuits* between the thalamus & cortex are essential for determining the *level* of consciousness.



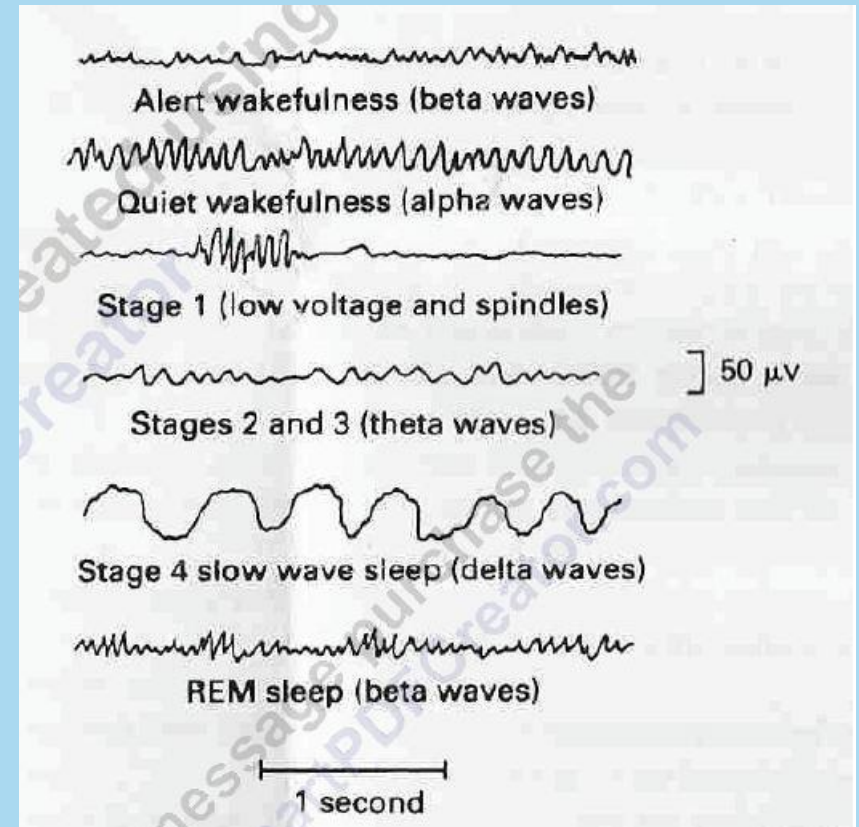
Indices (indicators) of Level of Consciousness

- Appearance & Behavior: posture (sitting, standing?), open eyes?. Facial expression?, responds to stimuli (including the examiner's questions about name, orientation in time & place ? & other general Qs like who is the president?)
- Physical signs: pulse, BP, respiration, pupils, **reflexes**, particularly brainstem reflexes, etc.)
- EEG → Each of these states (wakefulness, sleep, coma and death) has specific EEG patterns.
- Evoked potentials (in cases of Brain Death).

The EEG (Electroencephalogram) Normal (Waking State) Patterns

Routine EEG (Electroencephalogram) → is
recording of cortical activity from scalp
surface

- Alpha Rhythm :
- Observed **in** awake, relaxed adult humans with eyes closed وتختفي موجات ألفا بتخلف أحد هذه الشروط، ولما ينتبه يكون بيتا
- Frequency = **8 - 13** Hz
- Most prominent in the **Parieto-Occipital (posterior)** region, though it is sometimes observed in other locations
- When **attention** is focused on something the alpha rhythm becomes replaced by irregular low-voltage activity This phenomenon is known as **Alpha Block**



- * This replacement of alpha by irregular low-voltage activity is also called **Desynchronization** & **Alerting Response** كلمة خطأ ولن يأتي بها في الإختبار!
- * It is due to activity of RAS
- * However, the rapid EEG activity seen in the alert state is also synchronized, but at a higher rate. Therefore, the term "desynchronization" is misleading.

Alerting Response = Alpha block = Beta waves

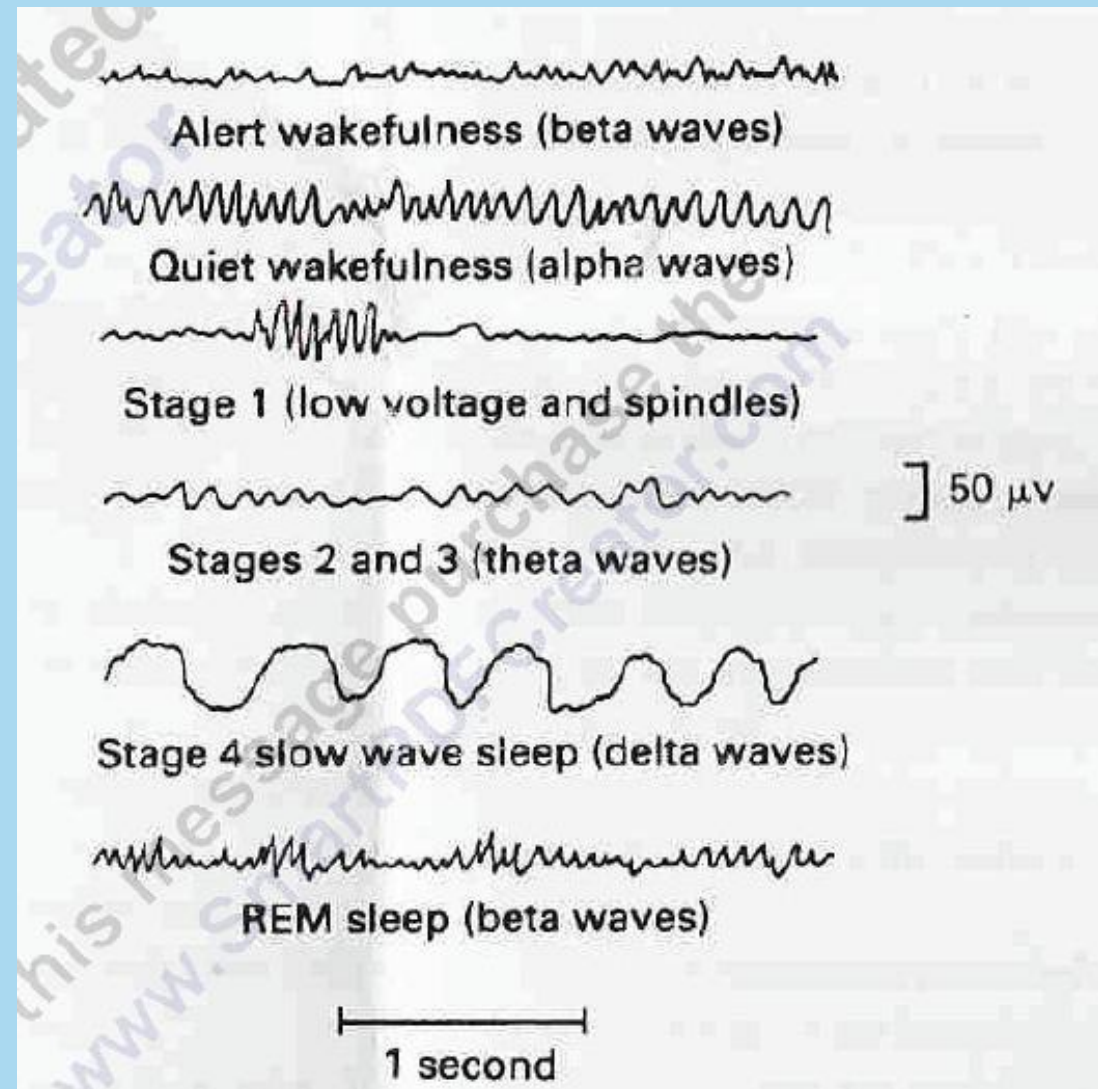
Beta Waves (a fast rhythm):

14-30 Hz , lower amplitude than alpha .
In **fully** awake person
In frontal regions.

Gamma Waves (a fast activity),:

30 -80 Hz .

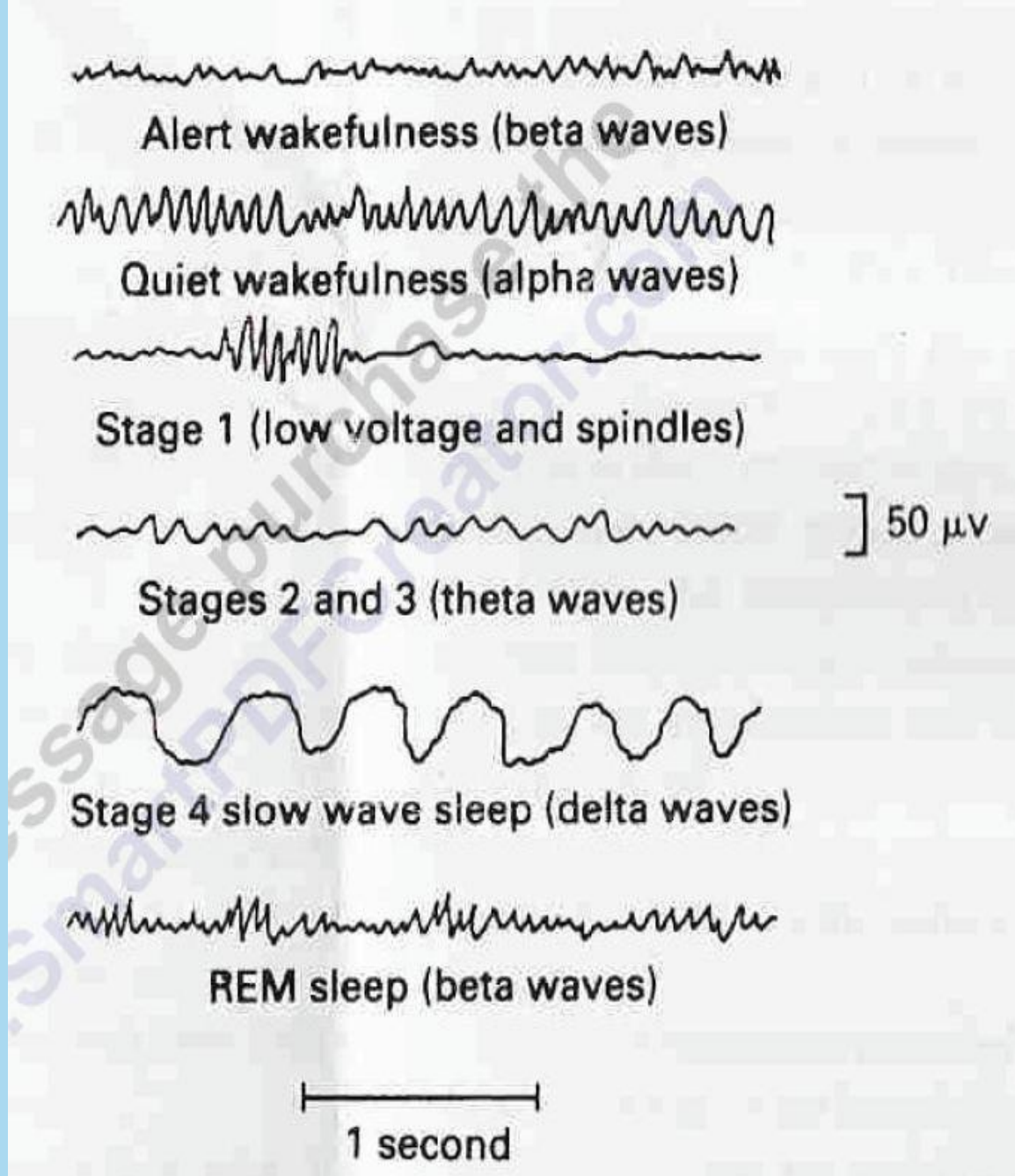
Effect of "Focused Attention" and/or alert Wakefulness .even if eyes are closed " : Often seen in a subject who is , on being aroused , focuses his attention on something (a particular object/person/animal ,etc.)..



- * Theta Waves :
- * Large amplitude, regular, 4-7 Hz activity
- * Occurs in **children** **الصاحي**
- * وتكون عند البالغ النائم

أما البالغ الصاحي يكون **إما** ألفا أو بيتا

- * Delta Waves:
- * Large amplitude, < 4 Hz waves
- * **In deep sleep and coma** **وعند** الأطفال حديثي الولادة .. والسبب في ذلك هو الماي لينيشن. يكونون كأنهم في غيبوبة!



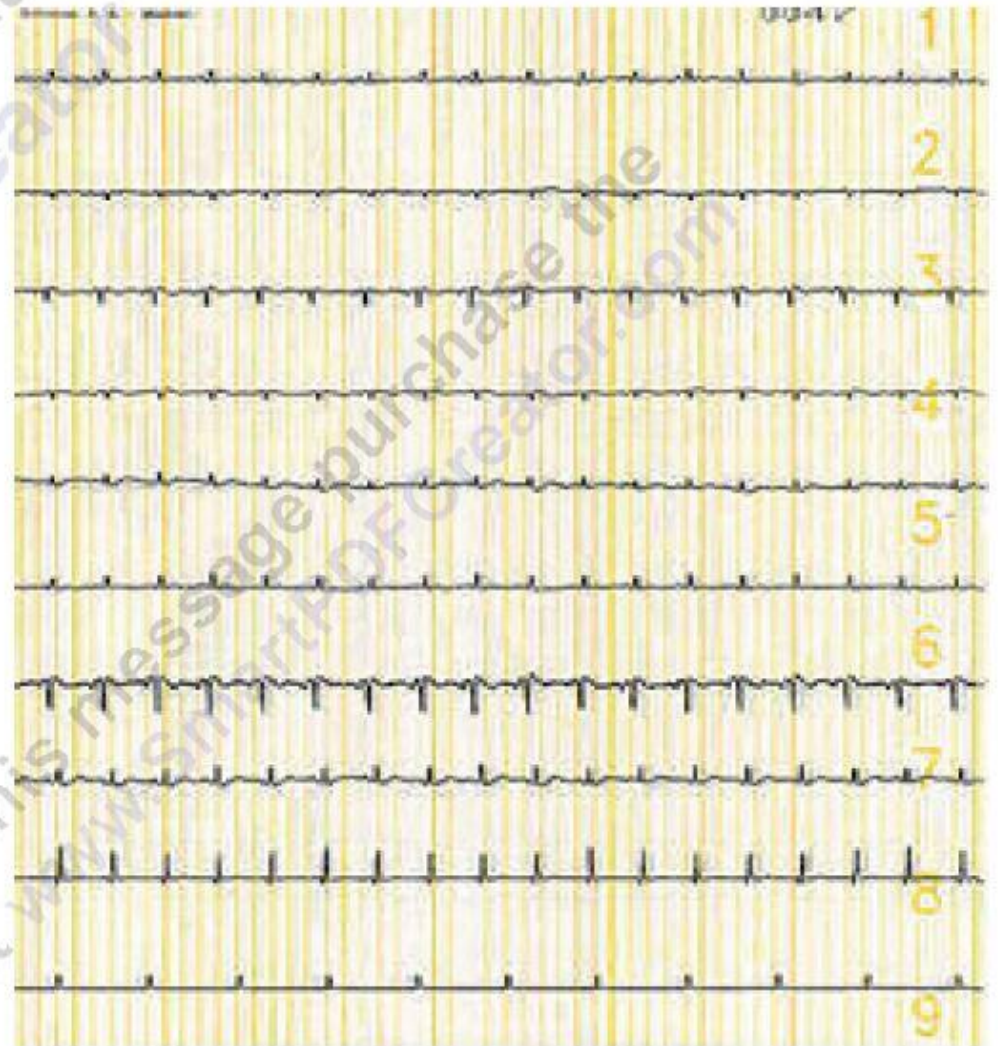
The Normal EEG is Largely **Age-Dependent**

- The EEG shows special features in different age groups of normal subjects.
- For example: EEG of premature babies is different from that of full-term newborn (even different grades of prematurity have different special EEG features, depending on the intrauterine age (حتى لو عمره ٢ أسابيع!)).
- During childhood the occipital rhythm changes from the delta range (0.5–2.0 Hz) in the newborn and **gradually increases** until it gets established at the alpha range.
- The age-dependent changes in childhood EEG are used as landmarks to indicate the **degree of** the child's cerebral growth & maturation.
- EEGs of early childhood, late childhood, adolescence, middle age and old age also have some differences.
- In cases of coma EEG may be dominated by delta waves
- In case brain death the EEG **is flat**, even at very high magnification (where only machine timing artefacts may be seen!!!! لا يا شيخ).

Brain Death Confirmatory Testing with EEG



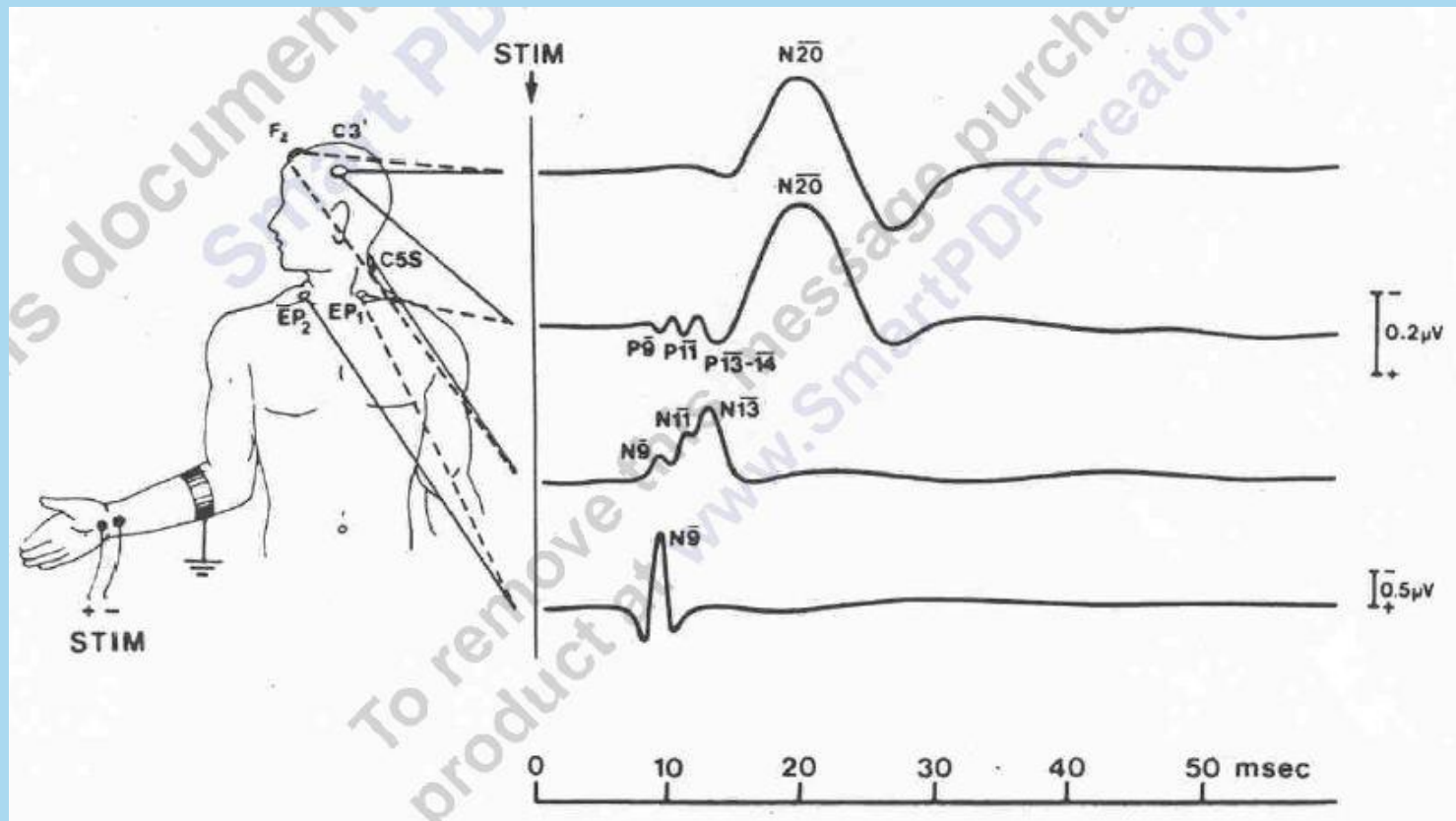
Normal EEG (at
normal
magnification)



Brain Death (Flat EEG ,at very high
magnification)

Brain Death Confirmatory Testing with Somatosensory Evoked Potentials

Stimulation of a sense organ can evoke a cortical response that can be recorded by scalp electrode over the primary receiving cortical area for that particular sense.



- Thanks