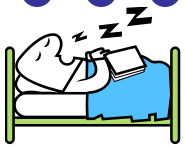



Snoring To Attention

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1st year Cognitive Science PhD Graduate

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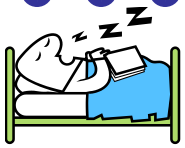


Abstract

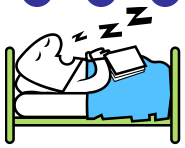
Why don’t you hear your own snoring, while your partner does?

A Perceptual Learning and Matching System (PLMS) is hypothesized that pre-attends the auditory scene during sleep with the goal of classifying sounds into the background to be ignored or into the foreground which will cause arousal for further conscious action. It is also active while an individual is awake and is responsible for the automatic acquisition of capabilities such as non-conceptual linguistic components.

In the case of chaotic snoring sounds, the partner’s PLMS cannot detect a pattern and will awaken the partner, while the snorer’s PLMS will correlate the snoring sounds directly with the individual’s own breathing pattern and hence, ignore it.

The main purpose of this investigation is to understand the functional characteristics of PLMS during a sleep paradigm which is not confounded by consciousness nor rationality. PLMS is a hitherto new cognitive system not before studied.

A secondary purpose is to investigate whether the PLMS of the snorer’s partner can be trained to ignore the snoring sounds. Several experiments are proposed to verify this possibility. Partners of snorers may be more affected than the snorers themselves!

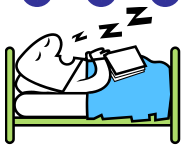


Hypothesis

A Perceptual Learning and Matching System (PLMS) is hypothesized that:

- pre-attends the auditory scene during sleep
- with the single goal of classifying sounds into the
  - background to be ignored, or into the
  - foreground which will cause arousal for further conscious action
- is also active while awake and responsible for
  - Automatic acquisition of capabilities such as non-conceptual linguistic components

Although such arousal behaviour is well known, proposing a cognitive system behind it is novel.



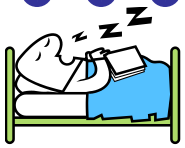
Not Hearing Own Snore?

- Pattern Classification
  - Regular patterns are safe, e.g.,
    - swaying of trees in the breeze
    - white noise from a waterfall
  - Irregular patterns are potentially dangerous, e,g.,
    - snapping of twigs (from a stalking predator)
- Snoring has a chaotic pattern
  - Partner of snorer cannot learn pattern

    →classified into the foreground; causes arousal

    ❖The point is not whether you can consciously hear the snoring, but whether it differentially affects your sleep.
  - Snorer does learn pattern
    - It is 100% correlated to self breathing

    → classified into the background and ignored



Purpose - Primary

To understanding the functional characteristics of the PLMS:

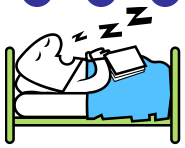
- What patterns can be learned and how long does this take?
  - Intensity, frequency, pitch, regularity, etc.
  - What about self patterns?
  - Person's name
- What patterns are classified into the background or foreground?
  - What causes a sound to transit from the background to the foreground and how long do these decisions take.
  - What pattern deviations are detectable? How many deviations are required?
  - Is it the "dangerousness" of sounds that causes arousal, or simply any sound associated with urgent action? Do sounds have intentionality?
- How many sounds "objects" can be simultaneously tracked?
  - How are sound clusters grouped?
- Other modalities
  - Touch (changes in pressure or electrical stimulation)
  - Visions (changes in lighting conditions)

Purpose – Secondary*

Can the PLMS of a partner be trained to ignore the snoring sounds of others?

For example, by synchronizing the other's snoring sounds to their own breathing patterns, or by filling in extra snoring sounds to create a repetitive pattern.

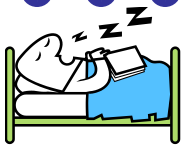
*Likely the best purpose for funding



Snoring Prevalence

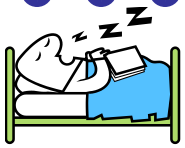
Prevalence	Male	Female
Snoring	48%	34%
Obstructive Sleep Apnea (OSA)	3.5%	1.5%
Adults Partnered	61%	

→ Impact to partner may be greater than impact to snorer!



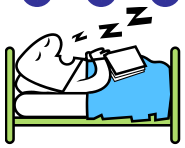
Snoring Impacts

- Loss of sleep
  - 26% of partners affected
  - 49 minutes lost on average per night
  - 20% road accidents caused by those excessively tired
- Social Relationships
  - 23% couples sleep in separate rooms
  - 8% alter their sleep schedules, e.g., non-snorer goes to sleep first
  - 24% have their intimate relations affected (vs. 9%)
  - 35% have relationship problems (vs. 9%)
- Hearing Loss
  - 30 dBA is the recommended bedroom noise level
  - exceeded 40 dBA by 78.7% (bothers others in same room),
  - exceeded 50 dBA by 34.4% (bothers others in another room),
  - exceeded 55 dBA by 12.3%, (max allowed outdoor night-time noise),
  - exceeded 70 dBA – none indicated (hearing can be impaired)
  - Nevertheless, closest ear implicated in hearing loss.



PLMS Functional Blocks

- Learning system
  - Short and long term learning
  - Finds (self-similar) patterns in the world
  - Creates long term non-conceptual categories (e.g., phonemes)
- Matching/classification pre-attentional system
  - Sleep: foreground/background (quick-slow)
  - Awake: phoneme categorization (quick)
- Object simulation
  - Can predict how an individual sound should change
  - Pre-attentive notification of deviations from prediction, e.g., mismatch negativity



Sleep Paradigm

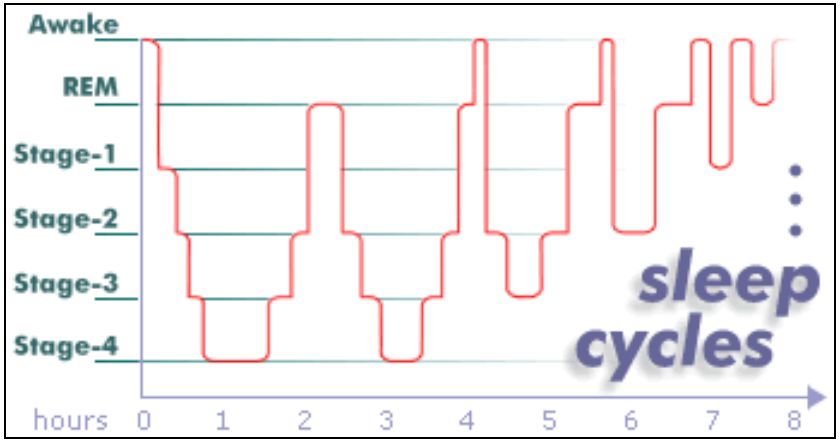
While a (non-snoring) subject is asleep,

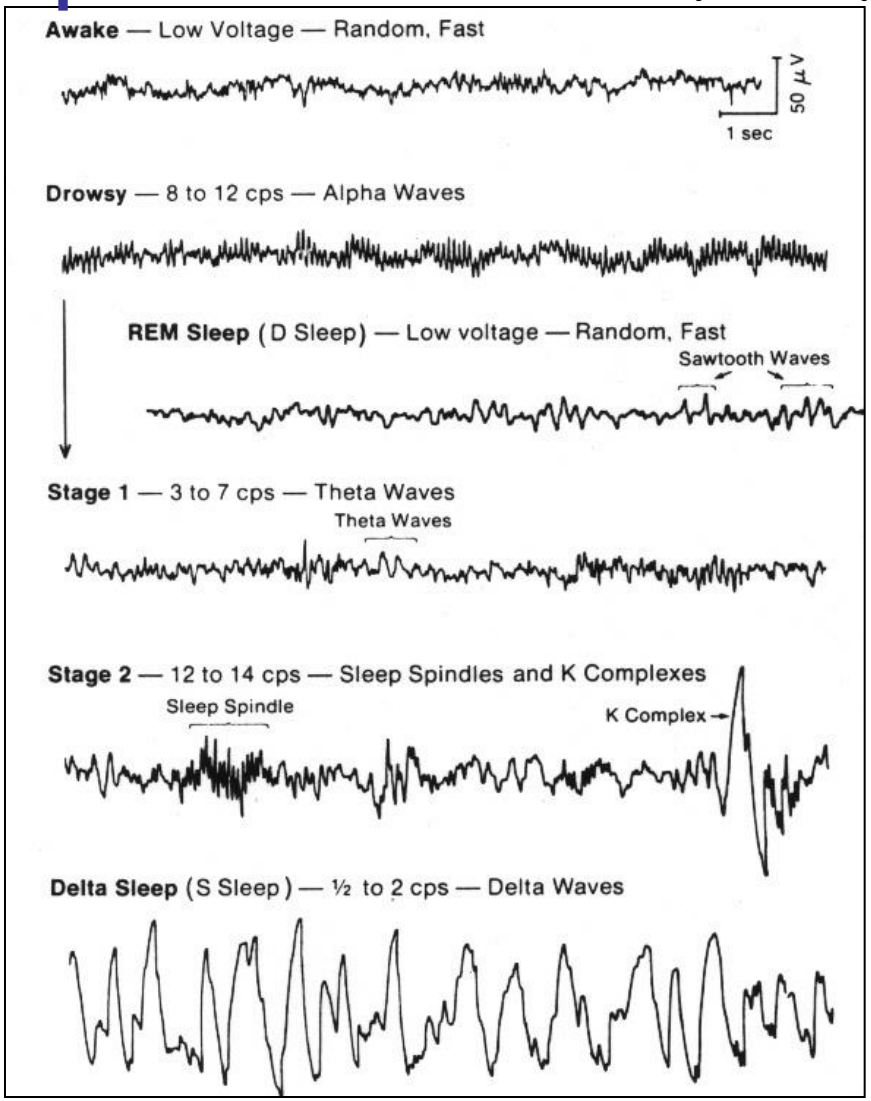
- Manipulate sensory information
  - Sound
  - Light
  - Touch
- Via various
  - Frequency changes; Pitch changes
  - Intensity changes (closer/further, moving left/right)
  - Temporal patterns (drum beats; regular/irregular)
- And measure what causes long term arousal
  - Repeat often for statistical relevance

Sleep

- Regular “arousals” every 90-100 minutes → repeat stimuli often for statistical relevance

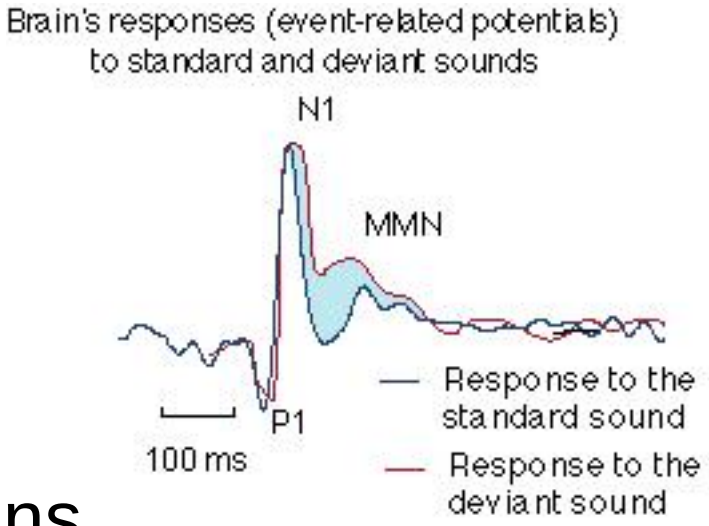
(pictures from thinkquest.org & Yale.edu)



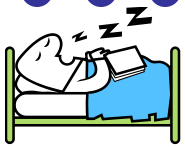


Mismatch Negativity (MMN)

- Auditory MMN sensitive to:
  - Frequency deviations
  - Pitch deviations
  - Intensity deviations
  - Temporal (rhythm) deviations
- Visual & touch counterparts
- Measured via an electroencephalography (EEG)
- Magnetoencephalography (MEG) counterpart → MMNm

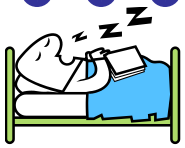


(Picture from Helsinki University)



Experiments 1-2

1. Record an individual's snoring (currently synchronised with breathing). Play it back another night (now unsynchronized). Does the individual awaken more often? What if the volume is reduced as they awaken?
2. Determine which self patterns are ignored. Record current breathing, teeth grinding & heartbeat. Amplify to snoring volume (or manipulate lights and pressure elements). Does the individual awaken more often?



Experiments 3-4 (Training)

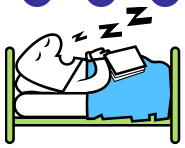
3. Generate synchronized snoring sounds over several nights. Does the "partner" awaken less often when unsynchronized snores are played back?
4. Generate repetitious (non-chaotic) snoring sounds over several nights. Does the "partner" awaken less often when chaotic snores are played back?

PLMS – New System

- Although detecting deviations (as done by mismatch negativity) occurs quickly, the decision to arouse an individual can take longer

- The study of PLMS is the study of this longer term decision maker

- Arousal by dangerous sounds is a known behaviour that has already been studied, however, proposing a cognitive system whose goal is to do just that provides a new outlook and a new set of research questions



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