

Can Stimulus Induced Neural Oscillations Improve Memory Performance?

Background

Declarative memory has been correlated with slow-wave sleep, where as procedural memory consolidation is correlated with REM sleep. (Gais & Born, 2004; Marshall, Helgadottir, Mølle, & Born, 2006)

Slow-wave sleep is characterized by delta activity, with a frequency of 1-4hz.

Neurons have been shown to synchronize with simple periodic auditory and visual stimuli. These include clicking sounds and flashing lights. (Berg & Will (2007); Lakatos *et al.*, 2008)

Research Questions

Does neural synchronization result from more complex periodic stimuli, such as rhythmic music and a matching visualizer?

Does neural synchronization to delta frequencies improve performance on a declarative memory task?

Stimuli

Three lists of 40 unrelated word pairs were compiled from a previous study.

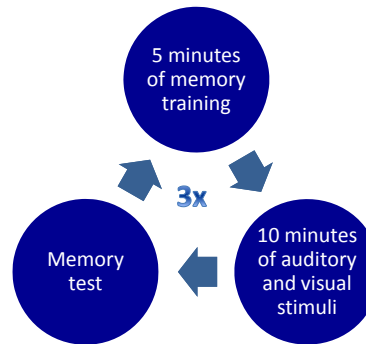
A 5 minute training program for each list was developed using E-Prime v2.0

Three conditions of auditory stimuli:

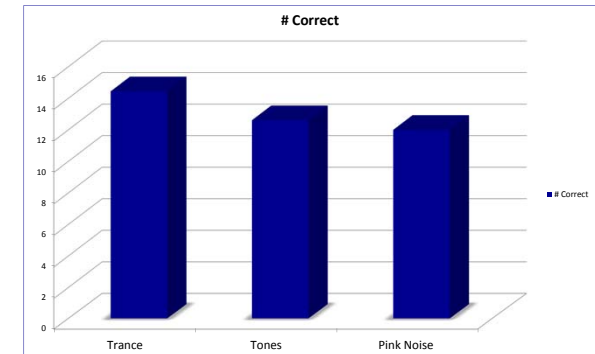
- ❖ Trance music (~2hz)
- ❖ Periodic Tone train (2hz)
- ❖ Pink noise

Each matched with a visual stimulus using Windows Media Player.

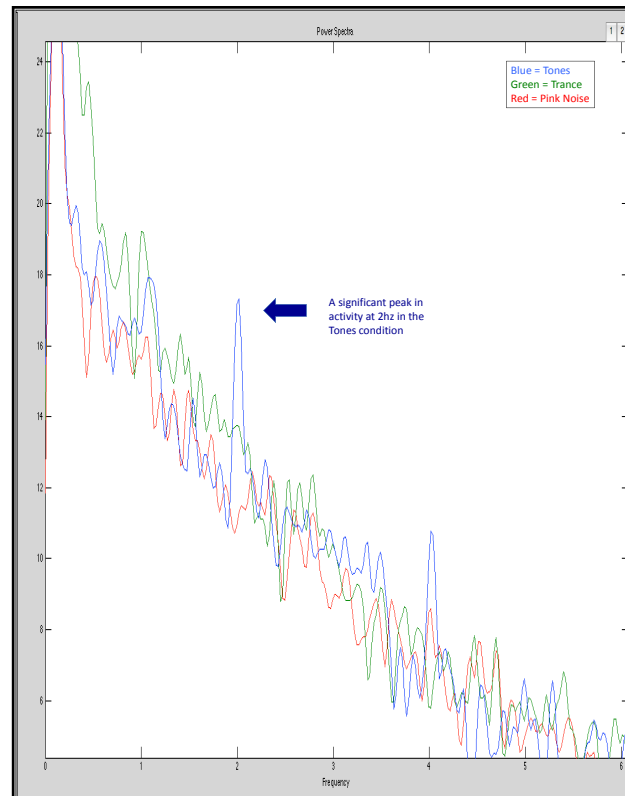
Procedure



Behavioral Results



EEG Results



Current Conclusions and Discussion

As evidenced by the above diagram, number of items recalled was highest in the Trance condition.

However, the diagram to the left represents the overall trend found in the EEG data. Neural synchronization only occurred in response to the Tones condition.

This suggests that **more complex auditory/visual stimuli do not synchronize neurons more strongly than simple stimuli**. There may be so much extra to process that the periodic beat is drowned out.

The fact that memory performance in the Tones condition was not significantly better than in the Pink Noise condition suggests **that neural synchronization to a delta range frequency does not improve conscious memory consolidation**.

References

- Gais, S., & Born, J. (2004). Declarative Memory Consolidation: Mechanisms Acting During Human Sleep. *Learning & Memory*, 11(6), 679-685.
- Lakatos, P., Karmos, G., Mehta, A. D., Ulbert, I., & Schroeder, C. E. (2008). Entrainment Of Neuronal Oscillations As A Mechanism Of Attentional Selection. *Science*, 320(5872), 110-113.
- Marshall, L., Helgadottir, H., Mølle, M., & Born, J. (2006). Boosting Slow Oscillations During Sleep Potentiates Memory. *Nature*, 444(7119), 610-613.
- Will, U., & Berg, E. (2007). Brain Wave Synchronization And Entrainment To Periodic Acoustic Stimuli. *Neuroscience Letters*, 424(1), 55-60.