

Introduction

BINAURAL BEATS

This study investigated the possibility of altering cognitive and brain states through **binaural auditory beats (BAB)**.

- A different tone is presented to each ear (e.g., 300 Hz to the left; 317 Hz to the right).
- Subjectively, the listener perceives a single tone, midway between the two.
- Physiologically, the auditory brainstem is thought to generate a corresponding rhythm (e.g., 17hz).

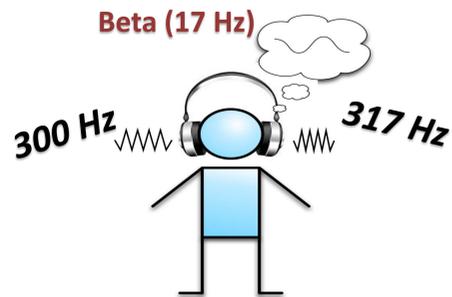


Figure 1. BAB procedure

BRAINWAVE ENTRAINMENT

- Studies have suggested that BAB can **entrain** specific brain rhythms (e.g., beta, ~13-25 Hz; theta, ~4-7 Hz) (Pratt, et al., 2009)
- Different brainwaves may predict different outcomes on cognitive tasks (Hanslmayer et al., 2008, Lane et al., 1997)
- However, studies have yielded conflicting results (Vernon, et al., 2012). Few attempted to validate BAB via direct measurement of EEG.

Study Goals & Hypotheses

STUDY GOALS

- Test whether BAB will induce greater beta (or theta), compared with baseline
- Validate BAB so we can use it to test hypotheses about the neural basis of word learning.

HYPOTHESES

- Presentation of BAB of a specific beat frequency will correlate with **Frequency Following Response (FFR)** of the same frequency
- Entrainment with beta will predict better target detection, reflecting improved vigilance; theta will have the opposite effect.

Experimental Paradigm

- ❑ **PARTICIPANTS:** Native English-speaking adults (n=5). One participant omitted due to excessive artifacts.
- ❑ **STIMULI:** A 15-minute continuous sequence of letters, BAB of 4 Hz (theta) and 17 Hz (beta). Each participant exposed to all three conditions.
- ❑ **TASK:** Press the response key as soon as you see the letter 'X'.

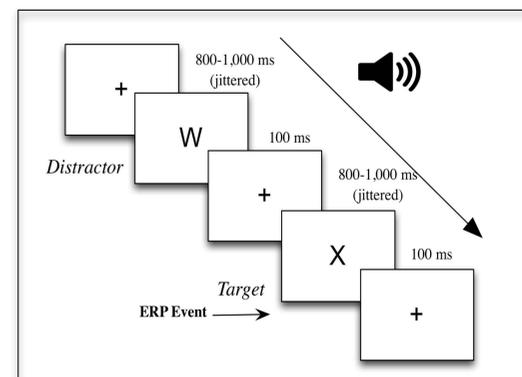


Figure 2. Visual Target Detection task (VTD)



Figure 3. 256-channel EEG net.

Conclusions

- ❑ Entrainment to beta and theta frequency ranges occurred, as hypothesized
- ❑ Data supported left temporal localization of entrainment effect as reported in Pratt et al.
- ❑ Theta power peaked early in the theta BAB condition. Latency of theta peak was suppressed in beta BAB condition
- ❑ No clear differences in behavioral results across conditions, likely due to a difference from the paradigm used by Lane et al.

Future Directions

- ❑ Replicate effect when BAB are auditorily masked, so that participants do not consciously attend to the different rhythms (Lane et al. 1997).
- ❑ Replicate entrainment effects during word learning task to test BAB entrainment effects on new word retention
- ❑ Test efficacy of BAB as a nonpharmaceutical adjunct to neurofeedback therapy in ADHD children (Clarke et al. 1998)

References

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Acknowledgments

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Results

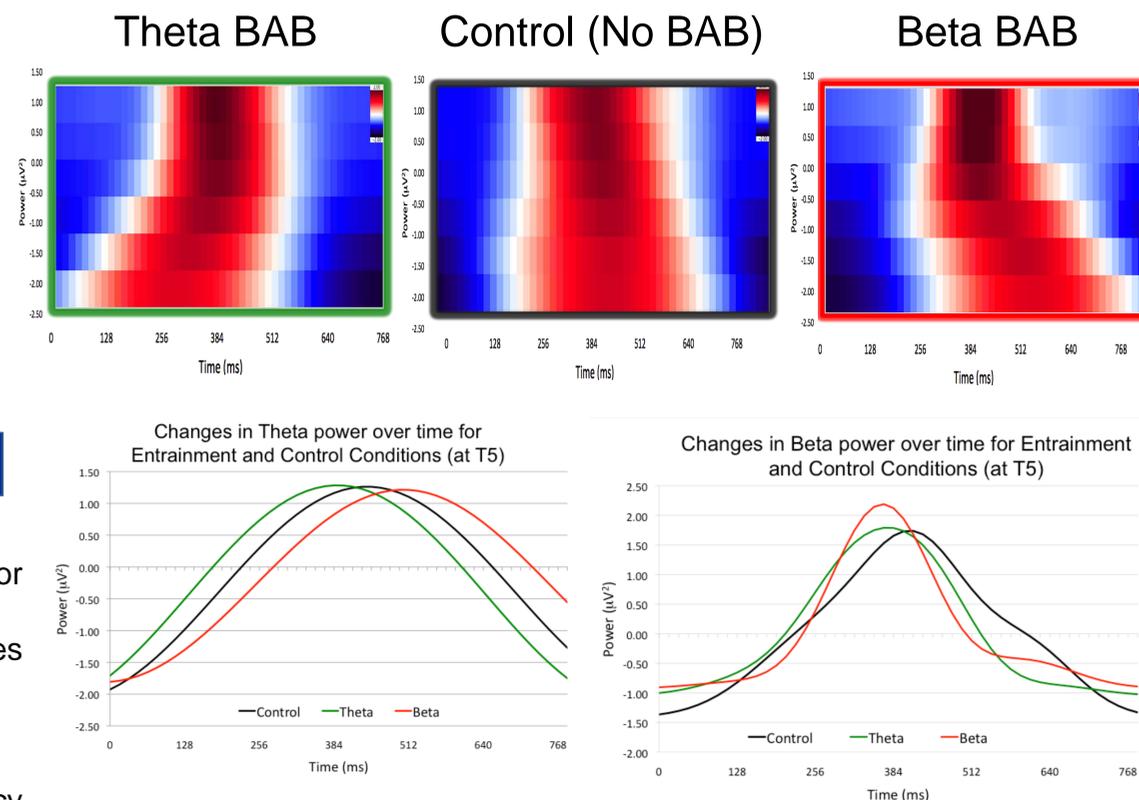


Figure 4. Results of Joint Time-Frequency Analysis (JTF). Top, JTF plots showing increases in power from 0–800 ms for frequency bands ranging from 4 Hz to 20 Hz Bottom left, changes in theta power over time for the three conditions at electrode T5 (left temporal). Bottom right, changes in beta power at T5.