

DEVELOPMENT OF A NOVEL EEG-BASED NEUROFEEDBACK PROTOCOL BASED ON ALPHA-THETA CROSS-FREQUENCY INTERACTIONS IN THE CONTEXT OF STRESS REGULATION: A PROTOCOL PRESENTATION

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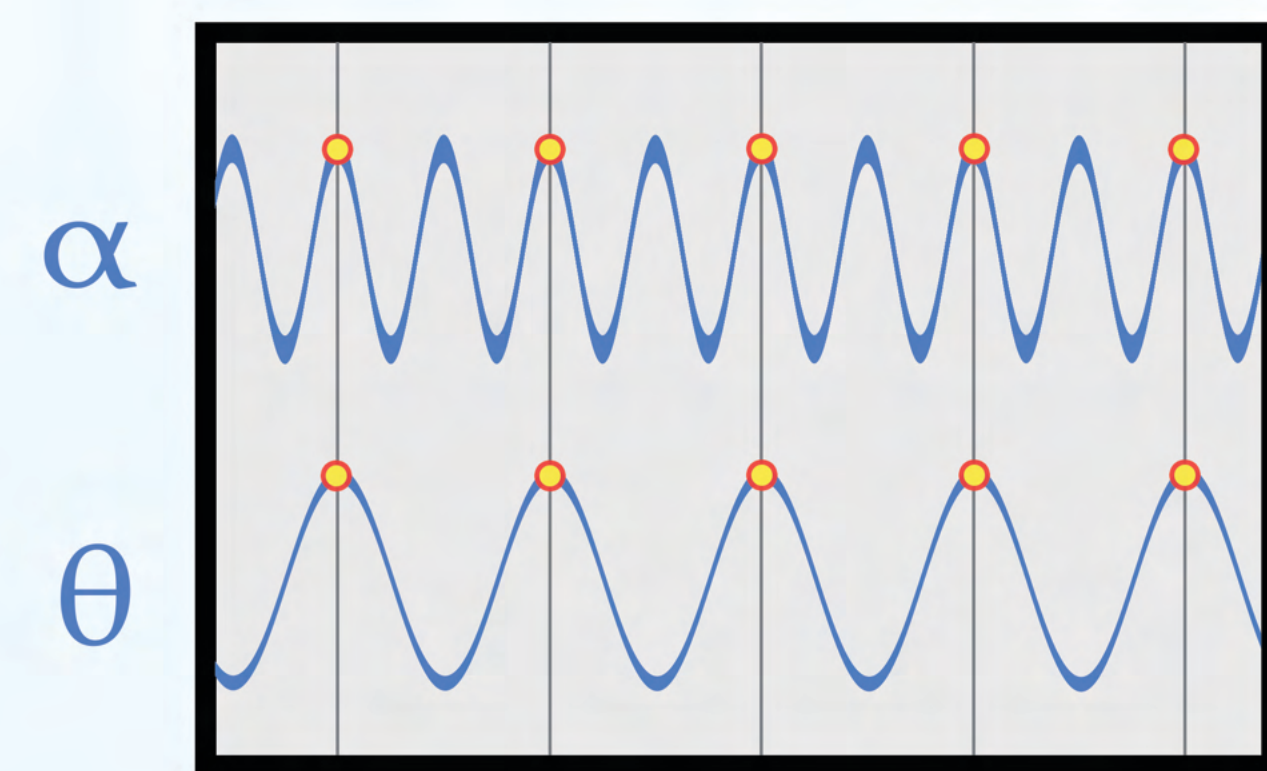
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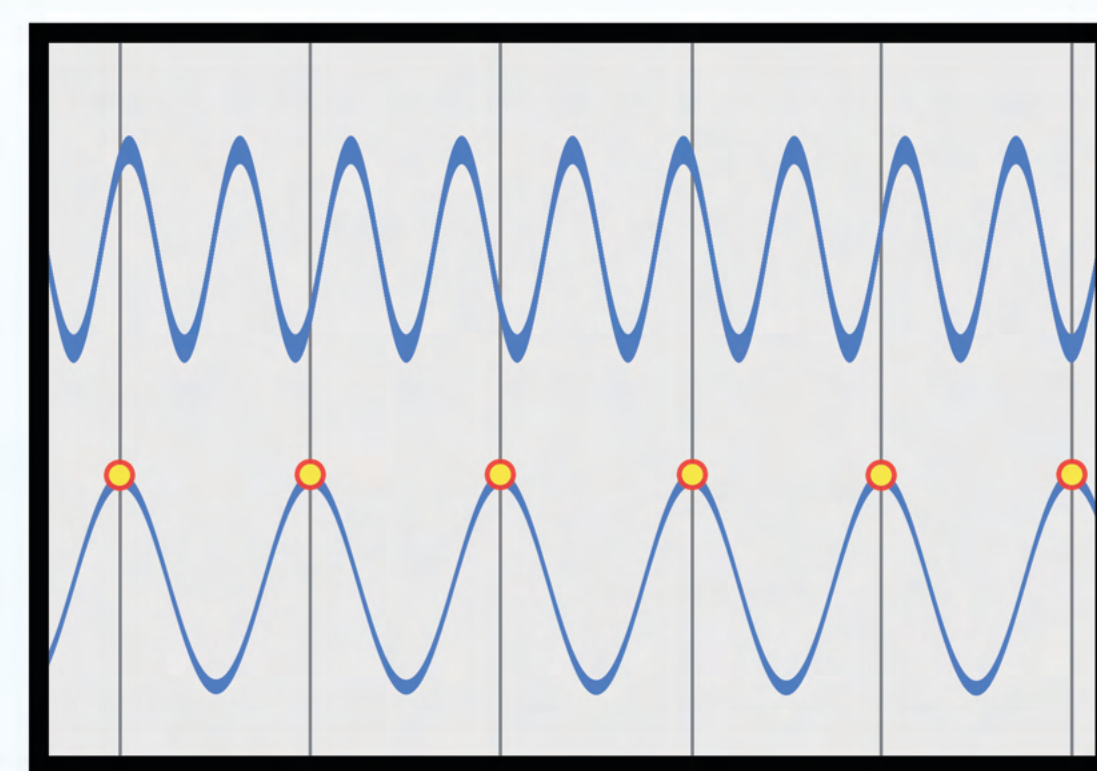
BACKGROUND

- **NEUROFEEDBACK TRAINING** IS A NON-INVASIVE TREATMENT AIMED AT HELPING INDIVIDUALS **ACHIEVE A PREDEFINED BRAIN STATE** THROUGH OPERANT CONDITIONING.
- **GOOD EFFICACY** HAS BEEN ESTABLISHED FOR NEUROFEEDBACK TRAINING IN TERMS OF UP- OR DOWNREGULATING OSCILLATORY POWER IN **SPECIFIC FREQUENCY BANDS**.
- YET, OSCILLATIONS IN DIFFERENT FREQUENCY BANDS ALSO **INTERACT WITH ONE ANOTHER** BY SHIFTING THEIR PEAK FREQUENCIES, THEREBY FACILITATING **CROSS-FREQUENCY NEURAL COUPLING OR DECOUPLING**^{1,2}.



NEURAL COUPLING
($\alpha = 10$ hz $\theta = 5$ hz)

- ALPHA AND THETA PEAK FREQUENCIES DYNAMICALLY SHIFT TO **MAXIMIZE** REGULAR EXCITATORY PHASE MEETINGS.
- REFLECTED BY A **HARMONIC** CROSS-FREQUENCY RATIO OF 2 (= 10 hz/5 hz).



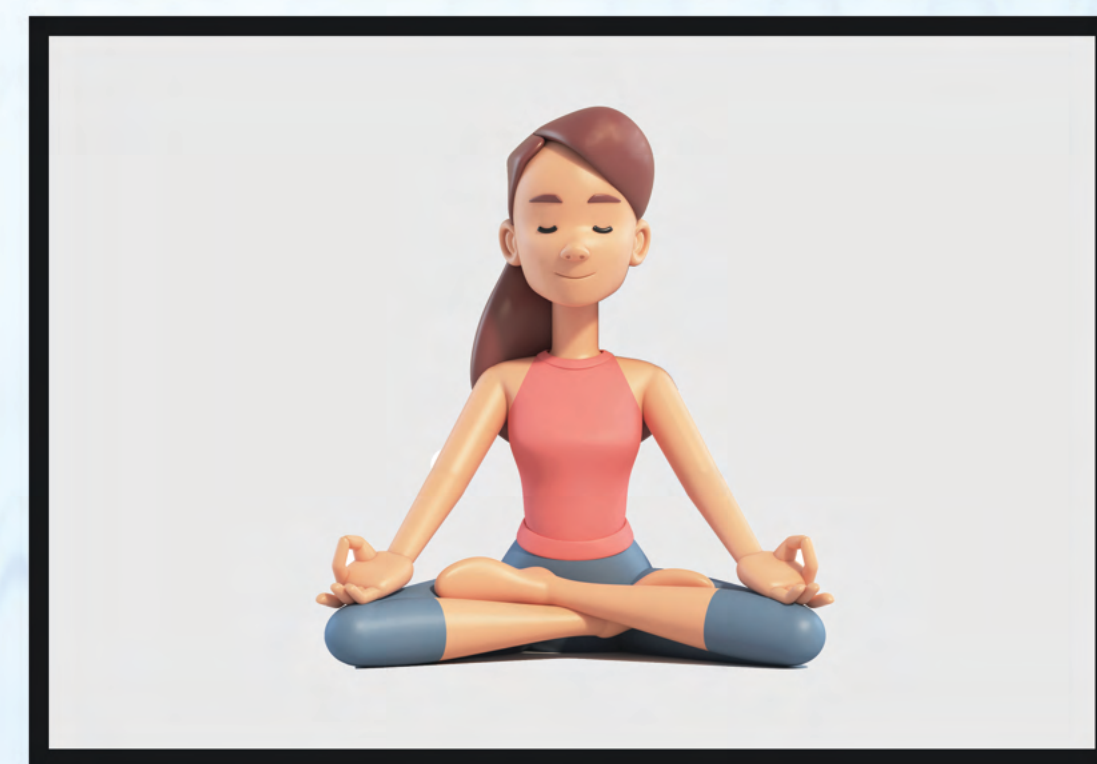
NEURAL DECOUPLING
($\alpha = 9.2... \text{ hz}$ $\theta = 5.7... \text{ hz}$)

- ALPHA AND THETA PEAK FREQUENCIES DYNAMICALLY SHIFT TO **MINIMIZE** REGULAR EXCITATORY PHASE MEETINGS.
- REFLECTED BY A **NON-HARMONIC** CROSS-FREQUENCY RATIO OF 1.618 (= 9.2... hz/5.7... hz).



COGNITIVE PROCESSING

- **ALPHA AND THETA RHYTHMS** ARE ASSOCIATED WITH THE **MANIPULATION AND STORAGE OF INFORMATION**³.
- ACCORDINGLY, **ALPHA-THETA COUPLING** UNDERLIES A STATE OF **COMPLEX COGNITIVE PROCESSING** SUCH AS MENTAL ARITHMETICS OR MEMORY RETRIEVAL^{4,5}.
- CONVERSELY, **ALPHA-THETA DECOUPLING** HAS BEEN ASSOCIATED WITH **MEDITATIVE PRACTICES** AND MAY UNDERLIE **THE BRAIN AT REST**⁶.



MEDITATIVE STATE

AIMS AND HYPOTHESES

- ALPHA-THETA COUPLING AND DECOUPLING ARE REFLECTED BY **HARMONIC AND NON-HARMONIC** ALPHA-THETA PEAK FREQUENCY RATIOS, RESPECTIVELY.
- HARMONIC RATIOS ARE ASSOCIATED WITH **COMPLEX COGNITIVE PROCESSING**, WHILE NON-HARMONIC RATIOS ARE ASSOCIATED WITH **MEDITATIVE STATES**.
- IN THE CURRENT STUDY, WE AIM TO **ASSESS THE TRAINABILITY OF HARMONIC AND NON-HARMONIC ALPHA-THETA PEAK FREQUENCY RATIOS** THROUGH THE USE OF SINGLE-SESSION **NEUROFEEDBACK TRAINING**.

HYPOTHESES

H1 FOLLOWING AN ALPHA-THETA **HARMONICITY TRAINING**, PARTICIPANTS WILL EXHIBIT A HIGHER OCCURRENCE OF ALPHA-THETA PEAK FREQUENCY RATIOS APPROXIMATING **2.0**, WHEREAS NO CHANGES WILL BE OBSERVED FOLLOWING A SHAM TRAINING.

H2 FOLLOWING AN ALPHA-THETA **NON-HARMONICITY TRAINING**, PARTICIPANTS WILL EXHIBIT A HIGHER OCCURRENCE OF ALPHA-THETA PEAK FREQUENCY RATIOS APPROXIMATING **1.618**, WHEREAS NO CHANGES WILL BE OBSERVED FOLLOWING A SHAM TRAINING.

METHODS

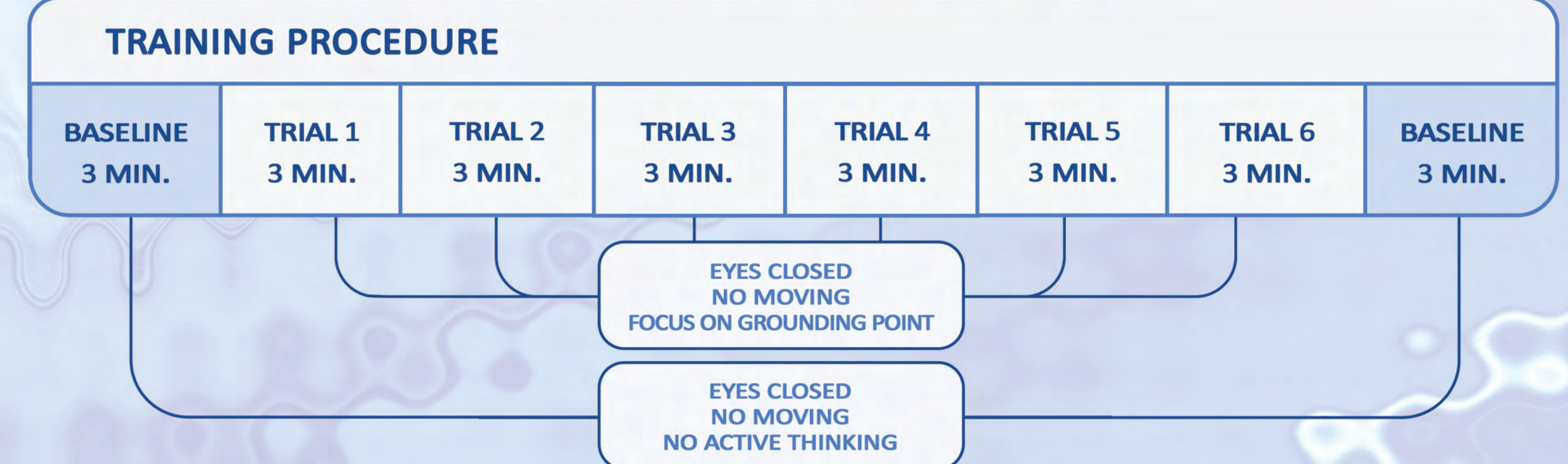
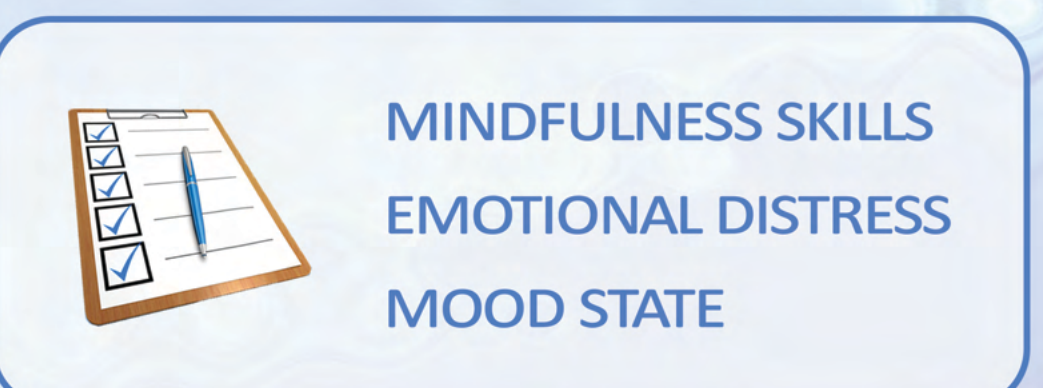
- A SINGLE-BLIND **WITHIN-SUBJECTS DESIGN** WILL BE EMPLOYED FEATURING THREE CONSECUTIVE SINGLE-SESSION NEUROFEEDBACK TRAININGS, **RANDOMIZED** IN ORDER OVER PARTICIPANTS: ALPHA-THETA HARMONICITY TRAINING, ALPHA-THETA NON-HARMONICITY TRAINING, AND SHAM TRAINING.
- DURING EACH TRAINING TRIAL, PARTICIPANTS ARE INSTRUCTED TO FOCUS THEIR ATTENTION ON A **GROUNDING POINT** (E.G., THE FEET) WITH THEIR EYES CLOSED. UPON APPROXIMATION OF THE DESIRED ALPHA-THETA PEAK FREQUENCY RATIO (MEASURED AT THE PZ CHANNEL), A **DISCRETE FEEDBACK SOUND** WILL BE PLAYED.

WITHIN-SUBJECTS DESIGN

- 3 RANDOMIZED CONDITIONS



27 PARTICIPANTS



- ALPHA-THETA HARMONICITY/NON-HARMONICITY WILL BE ASSESSED BEFORE AND AFTER EACH TRAINING (I.E., AT THE **BASELINE PERIODS**) AT **ALL SCALP LOCATIONS** (21 ELECTRODE EEG-CAP)
- STATISTICAL SIGNIFICANCE OF THE OBSERVED CHANGES WILL BE ASSESSED USING **PAIRED-SAMPLE T-TESTING**.

REFERENCES

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