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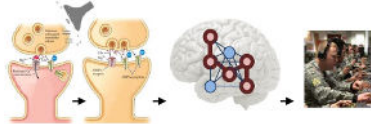
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DARPA Target Neuroplasticity Training (TNT) Program

Training + Non-Invasive PNS Stimulation

| Enhances Learning? | Specific? | Invasive? | Side Effects? |
|--------------------|-----------|-----------|---------------|
| Yes | Yes | No | No |



Defense Language Institute



- Department of Defense's premier foreign language learning center
- Train ~3,500 students annually in 14 languages
- In 36 to 64-week curriculum, it consistently prepares students to be mission-ready linguists capable of explaining and supporting opinions, hypothesizing, and dealing with unfamiliar topics through reading, writing, and conversing.
- Highly selected students; to be admitted, candidates have to score high on the Defense Language Aptitude Battery (DLAB), a test designed to measure one's ability to learn new languages
- Vocabulary acquisition is particularly challenging part of the curriculum (up to 30 words per day).



5-Day Vocabulary Learning Protocol

| DAY 1: BASELINE | DAY 2: TRAINING | DAY 3: TRAINING | DAY 4: TRAINING | DAY 5: FINAL TEST |
|--|---|---|---|---|
| <ul style="list-style-type: none"> • Consent • Eligibility Screening • Mood Questionnaires • Baseline Language Learning Test (Recall only) | <ul style="list-style-type: none"> • Mood Questionnaire • Priming Stim. • Learning task • Consolidation Stim. • Language Learning Test (Recall & Recognition) • Mood Questionnaires | <ul style="list-style-type: none"> • Mood Questionnaire • Priming Stim. • Learning task • Consolidation Stim. • Language Learning Test (Recall & Recognition) • Mood Questionnaires | <ul style="list-style-type: none"> • Mood Questionnaire • Priming Stim. • Learning task • Consolidation Stim. • Language Learning Test (Recall & Recognition) • Mood Questionnaires | <ul style="list-style-type: none"> • Mood Questionnaire • Final Language Learning Test (Recall & Recognition) • Mood Questionnaire • Debriefing |

Experiment 1 (Mandarin: N = 41 & Farsi: N = 20)

Xen by Neuvana



Control: After calibration, control participants were told that they would receive sub-threshold stimulation, but actually received no stimulation

Experiment 2 (Arabic: N = 36)

gammaCore by electroCore

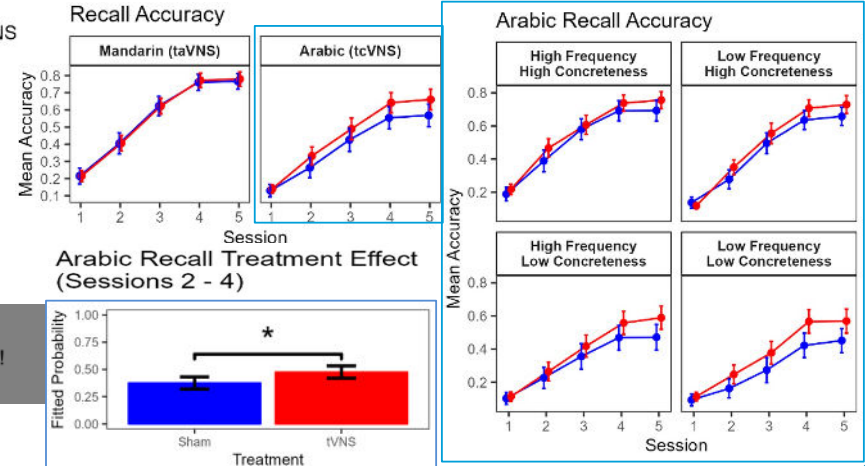


Control: A sham device that emitted sound and vibrations similar to the active device but gave no stimulation

tcVNS enhanced learning which was sustained after 24-hr delay

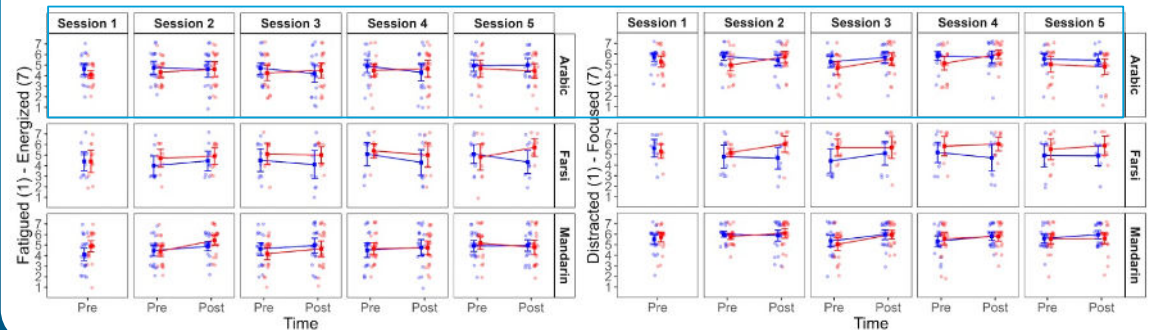
Session 1: Baseline test w/o tVNS
Session 2: Training with tVNS
Session 3: Training with tVNS
Session 4: Training with tVNS
Session 5: Final Test w/o tVNS

Recall and recognition (not shown as there were no significant effects) of 100 Foreign-English word pairs



tcVNS mitigated fatigue and promoted focus

Significant effect of tcVNS (Arabic) on pre-post change of the Fatigue-Energized, $p < .05$, and Distracted-Focused, $p < .001$, scales of the AFRL Mood Questionnaire



Funding & Acknowledgements

This work was supported by DARPA/AFRL Contract FA8650-14-D-6500 within the DARPA Targeted Neuroplasticity Training (TNT) program. All statements of fact, opinion or conclusions contained herein are those of the authors and should not be construed as representing the official views or policies of DARPA, AFRL or the U.S. Government. Contact: tmiyatsu@ihmc.org