Probing the effects of sleep reactivation on the kinematics and dynamics of motor execution with an EMG biofeedback task

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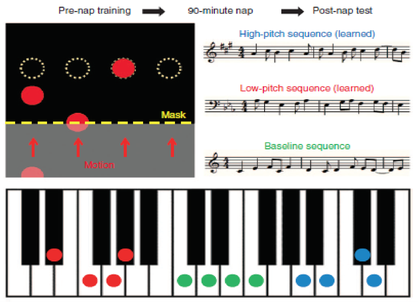
Sleep Replay

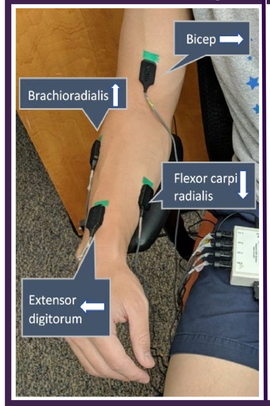
- Spontaneous memory reactivation was observed in rodents when hippocampal place cells fired in the same order during sleep as during prior spatial learning (Wilson & McNaughton, 1994).
- Tones linked with left/right movement and then delivered during sleep provoked replay of neural patterns in rodent hippocampal place cells (Bendor & Wilson, 2013).
- **Targeted Memory Reactivation (TMR)** has been demonstrated repeatedly, including with a complex motor skill task: pressing keys in time with moving visual cues to produce a "Guitar Hero" melody (Antony et al., 2012).



Can motor execution be enhanced with sleep reactivation?

- Previous studies have utilized finger tapping tasks to examine effects of sleep on motor sequence learning (e.g. Walker et al., 2002).
- We used a motor task adapted from one used in rehab for motor control; EMG feedback is used to guide both fine and gross control of arm muscles with *N* = 20 subjects aged 18-25 yrs.
- Subjects first learned motor responses in each arm, using EMG signals that moved a screen cursor. Targets appeared in 8 screen locations to cue responses, each associated with a unique sound.
- HYPOTHESIS: Sound stimulation during sleep can selectively enhance execution of newly learned skills.

EMG Setup



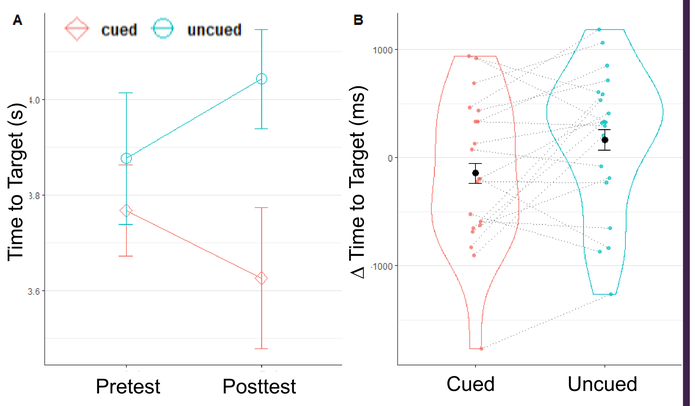
Motor Training on 16 EMG Responses with 16 Sounds

Conclusions

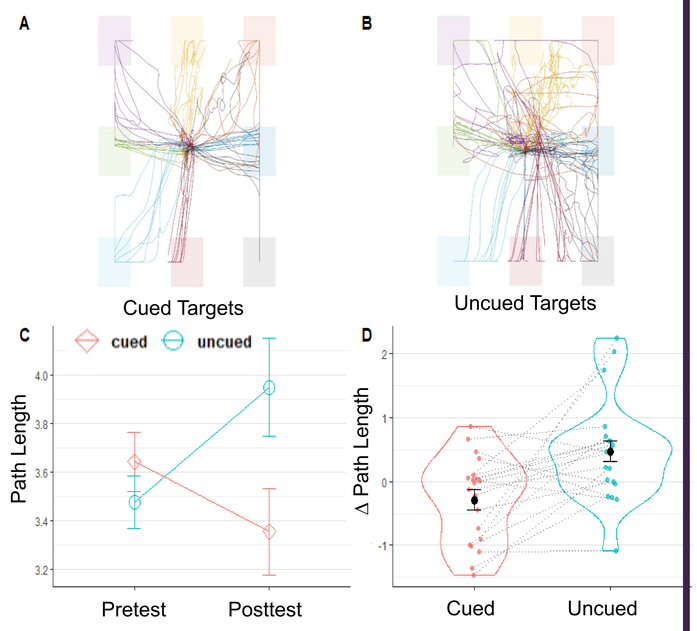
1. TMR during sleep selectively improved the kinematics and dynamics of motor skill execution.
2. Memory reactivation during sleep thus appears to support motor-execution learning.
3. The influence of sleep reactivation on motor learning goes beyond mere motor selection, which is the primary mediator of motor learning in typical motor sequence learning tasks.

Kinematics (motion)

Cueing decreased time to target

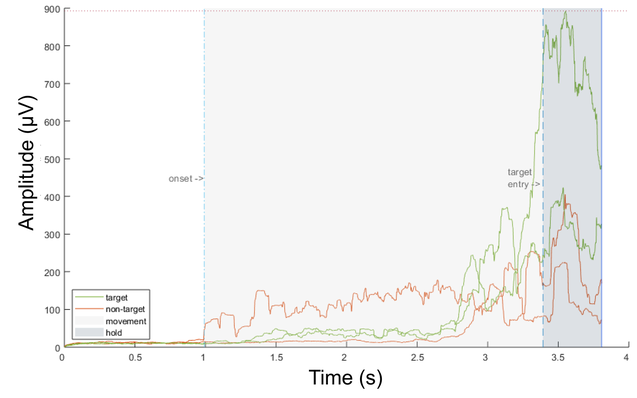


Cueing decreased path length

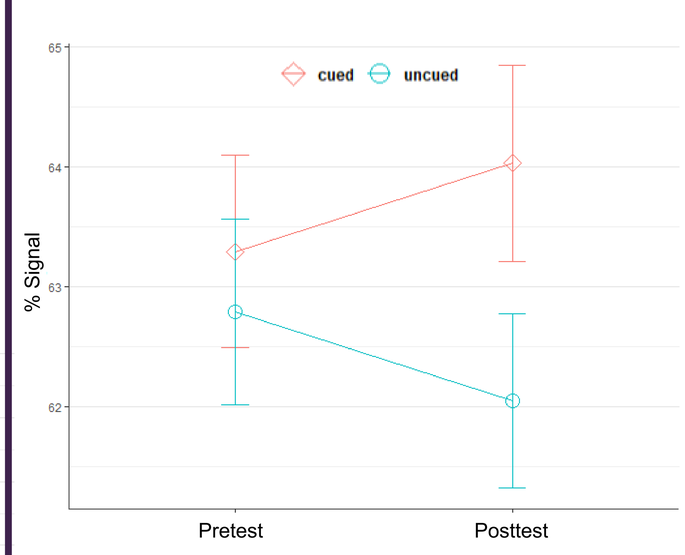


Dynamics (forces)

Example of EMG trial activity

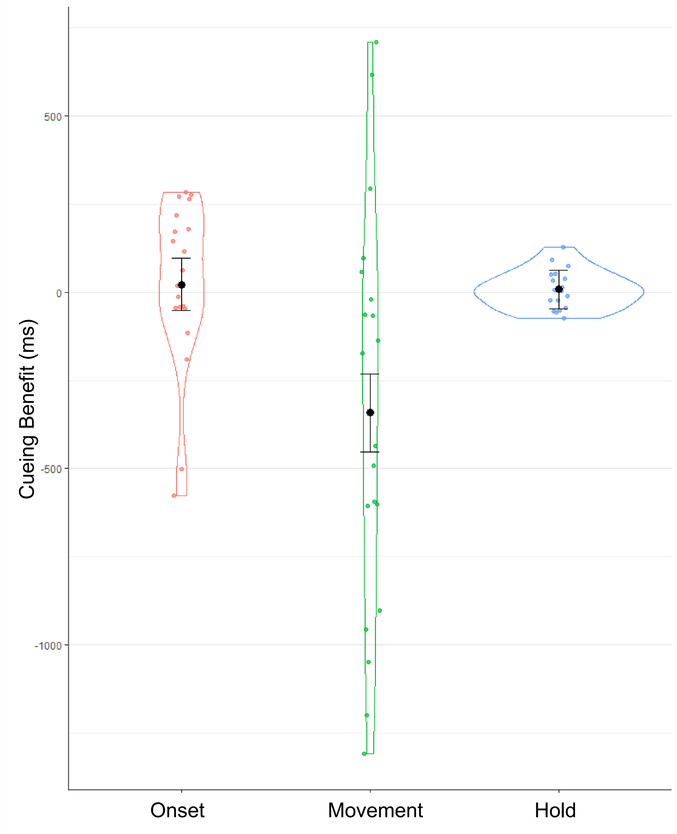


Cueing increased selective muscle control



Selection vs Execution

Cueing benefitted execution



References

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