Auditory-motor predictions after short motor training in non-musicians

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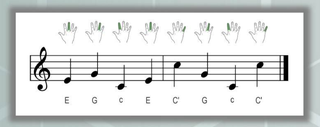
Background

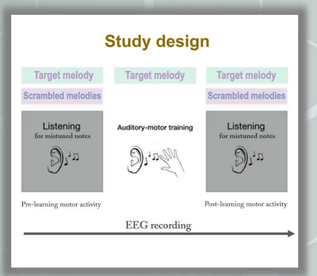
- **Auditory-motor coupling**: a bidirectional system crucial for speech and music[1]
- Motor activity **anticipates** learned sound sequences in passive listening contexts[2]
- **Mu suppression** (9-13Hz) over M1 anticipates learned melodies in musicians[3]
- Mu suppression has not been found in non-musicians nor for single notes

Methods

- 24 non-musicians underwent motor training of a simple **target** melody:



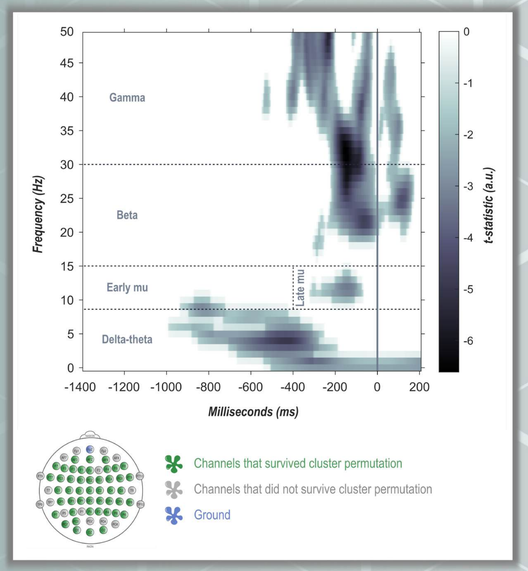
- Training was preceded and followed by 2 passive listening blocks:



- EEG data from the training part led to a time-frequency **functional localizer**:

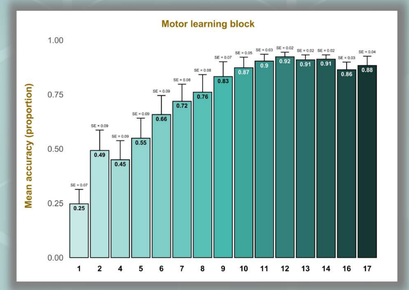
  (Pretone activity for correct keypresses — Resting period)

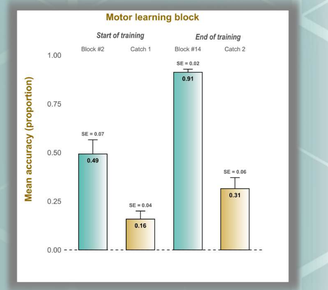
- The resulting clusters were divided into **5 regions of interest** (ROIs):



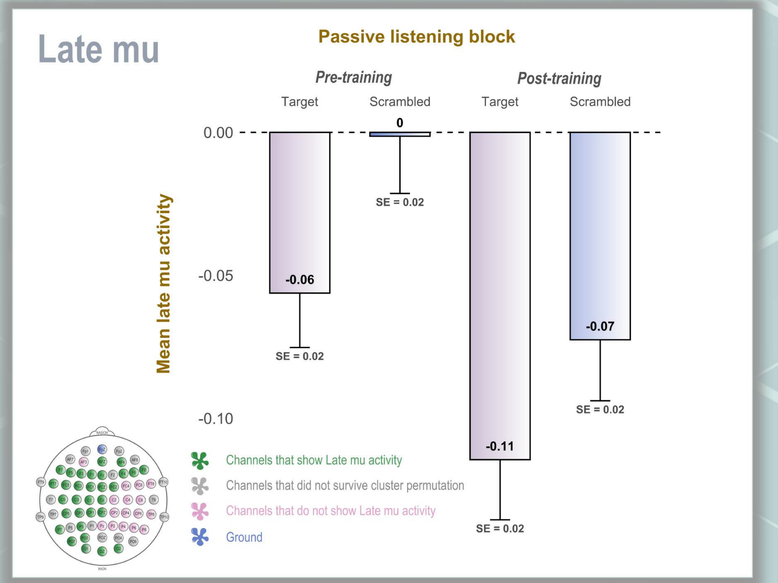
- Each ROI was used to **mask** the EEG data for the passive listening blocks
- A GLMM statistical approach was used to assess differences across blocks

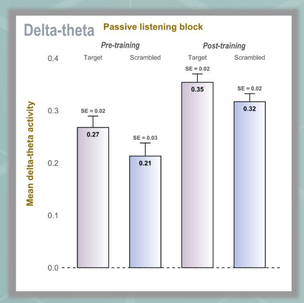
Behavior

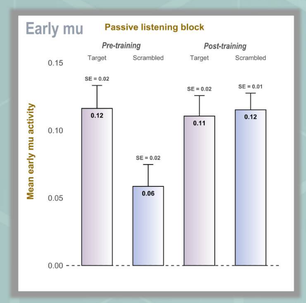


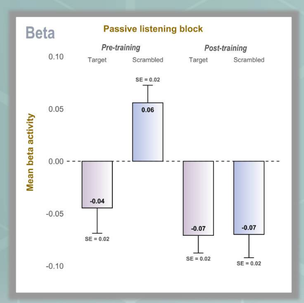


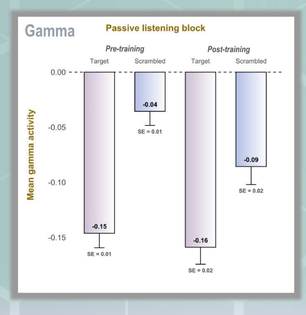
EEG results











Summary

- Participants learned the **target melody** and the tone-to-finger mapping
- The *training data* successfully **localized** mu suppression in *passive listening*
- **Late mu** ROI showed *suppression* in the *post-training target listening* block
- This effect was **only present** in Late mu, as originally hypothesized

Discussion

- Findings point to sequence-related anticipation, which is cognitively demanding[4]
- Findings support the common-coding theory that forward models aid perception[5]
- Effect cannot be **occipital alpha**[6]: 1) *fixation cross*; 2) *attentional distractor task*
- Prior literature *did not find* the effect[7], which indicates it may be **short-lived**

Future steps

- Base analysis on *subjects* instead of *channels* to explore **brain-behavior** effects
- Expand design to include the **beta band**, the other component of the *mu complex*
- Elucidate the precise role of **training length** and consolidation parameters
- Explore the relationship between **musical training** variables and mu suppression

References

[1] Iversen, J. R., & Balasubramaniam, R. (2016). Synchronization and temporal processing. *Current Opinion in Behavioral Sciences, 8*, 175–180.

[2] Stephan, M. A., Lega, C., & Penhune, V. B. (2018). Auditory prediction cues motor preparation in the absence of movements. *NeuroImage, 174*, 288–296.

[3] Wu, C. C., Hamm, J. P., Lim, V. K., & Kirk, I. J. (2016). Mu rhythm suppression demonstrates action representation in pianists during passive listening of piano melodies. *Experimental Brain Research, 234*(8), 2133–2139.

[4] Novembre, G., & Keller, P. E. (2014). A conceptual review on action-perception coupling in the musicians' brain: What is it good for? *Frontiers in Human Neuroscience, 8*, 603.

[5] Halász, V., & Cunnington, R. (2012). Unconscious effects of action on perception. Brain Sciences, 2(2), 130–146.

[6] Hobson, H. M., & Bishop, D. V. M. (2017). The interpretation of mu suppression as an index of mirror neuron activity: Past, present and future. *Royal Society Open Science, 4(3)*, 160662.

[7] Wu, C. C., Hamm, J. P., Lim, V. K., & Kirk, I. J. (2017). Musical training increases functional connectivity, but does not enhance mu suppression. *Neuropsychologia, 104*, 223–233.

Acknowledgments

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