What brain patterns should we reinforce during neurofeedback training procedures targeting motor imagery abilities ?

Margaux Izac, Léa Pillette, Franck Rienzo, Etienne Guillaud, Aymeric Guillot, Thomas Michelet, Camille Jeunet

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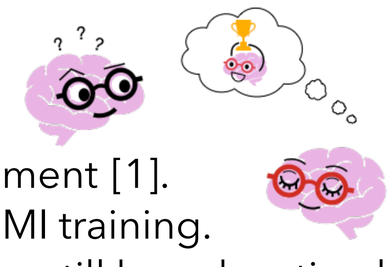
Neurofeedback(NF)-based motor imagery (MI) training



- MI can be defined as the act of simulating an action mentally without movement [1].
- NF might give us the opportunity to guide MI users more efficiently during MI training.
- However performance gains associated with NF/BCI training procedures can still be suboptimal.
- Individualised and out of the lab procedures might be the key to maximising those gains.

What is NF?

NF enables users to deliberately modulate their cerebral activity by targeting specific EEG patterns and informing the user in real time of the variations.

What for ?

Increase performance

By learning or re-learning

- Like action observation and execution
  - ↗ technical component
  - ↗ attentional focus

By managing emotions

- ↘ stress and anxiety levels [1]
- ↗ motivation and self-esteem

For whom ?

(Future?) experts

- Such as athletes during their cognitive training or stroke patients during motor rehabilitation.

How does it work ?

EEG NF

- Most of the current NF protocols reinforce the maximal modulation of sensorimotor rhythms (SMRs).

Why does it work ?

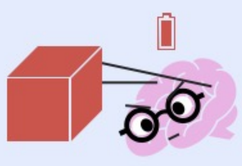
Brain plasticity

- Solicitation of premotor, parietal and somatosensory regions during MI, observation and execution [2]
- Therefore, MI is expected to induce plasticity that will result in performance gains

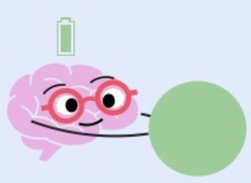
Our research question

What are the most relevant patterns to target ?

Current approach VS *Neural efficiency*



- Max event-related desynchronisation (ERD) of SMRs



- Min ERD of SMRs and min solicitation of other brain areas

What is neural efficiency?

Recent findings suggest a more efficient cortical function [3, 4] and minimal energy consumption [5] in experts.
This can be translated as a reduced activation of areas associated with task execution and a reduced deactivation of regions associated with irrelevant information processing [6].

Does neural efficiency depend on MI expertise in general or is it specific to mastered movements ?

Only during mastered tasks, as it is task and expertise specific [7] VS *During various tasks not in link with the expertise domain as it is general*

Experimental approach

Double dissociation paradigm

Objective

- Compare experts/non experts SMR modulations during MI tasks and observe differences in temporal/spatial stability as well as modulation amplitudes.
- Determine if expert modulations are specific to a movement that they have mastered or more general.

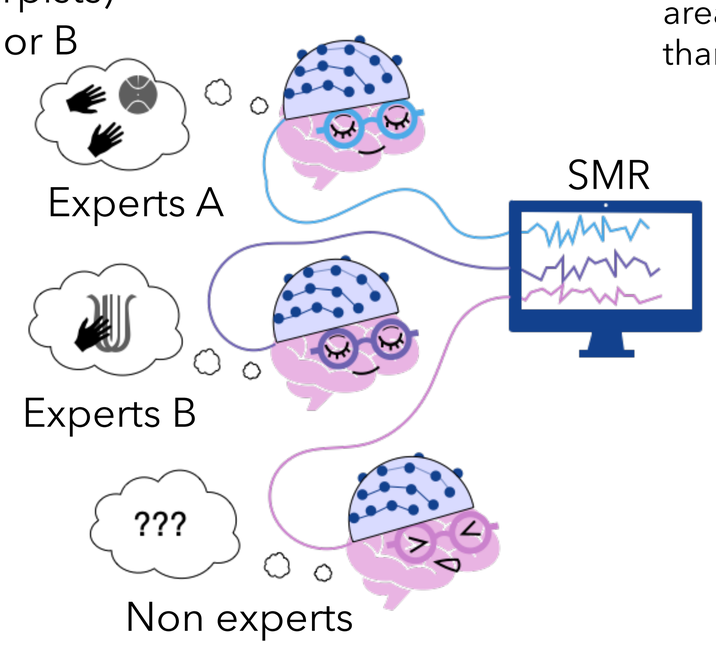
Participants

3 groups - Experts A (ex : basketball players)
- Experts B (ex : harpists)
- Non experts in A or B

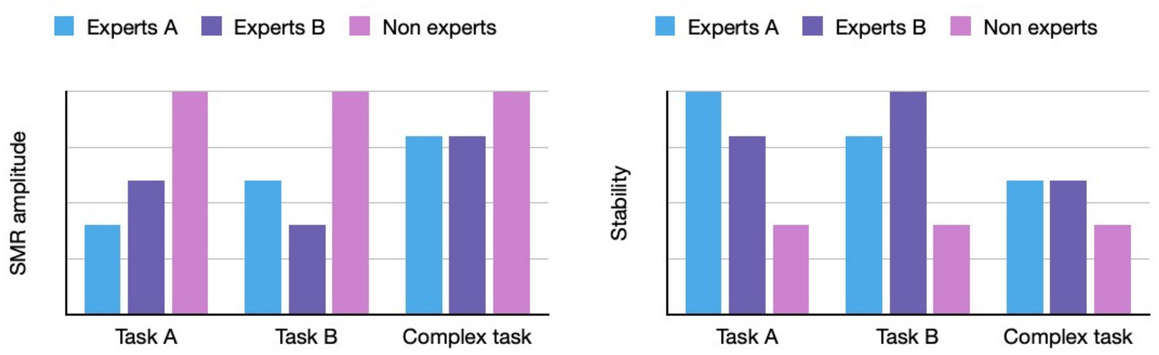
Protocol

	Experts A	Experts B	Non experts
MI of task A (ex basketball specific)	N=20	N=20	N=20
MI of task B (ex harp specific)	N=20	N=20	N=20
MI of complex uncommon task	N=20	N=20	N=20

Number of trials for each condition in each group. The conditions will be counterbalanced over participants.

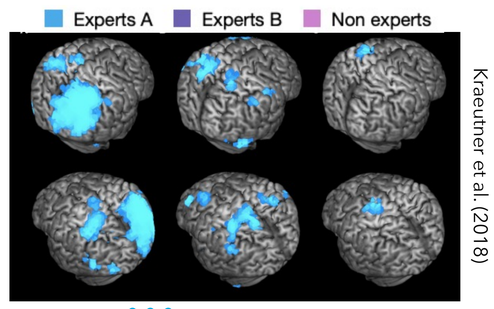


Expected results



- Experts have a better neural efficiency and stablity in all tasks
- These effects are even stronger in tasks mastered by experts

Hypothesis based on previous MEG study [7] where experts A and B activated more areas when doing MI of a complex task than when doing a mastered task.



Differences in activation shown between the task with low vs high degree of experience.

Let's talk

What should we reinforce during SMR-NF training?
Is the percentage of SMR-ERD actually relevant?
What experts in MI could we select?
What tasks should we ask the participants to imagine?

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