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

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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 ?

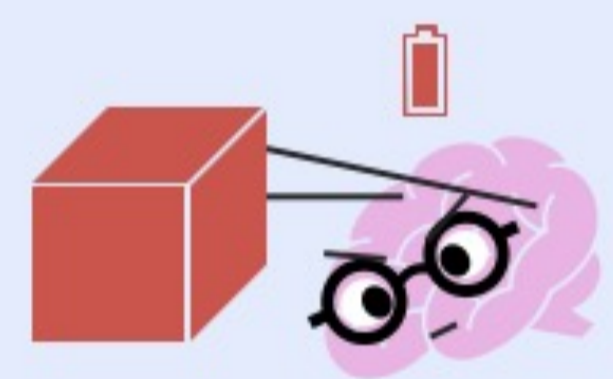
#### Brain plasticity

- 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 ?

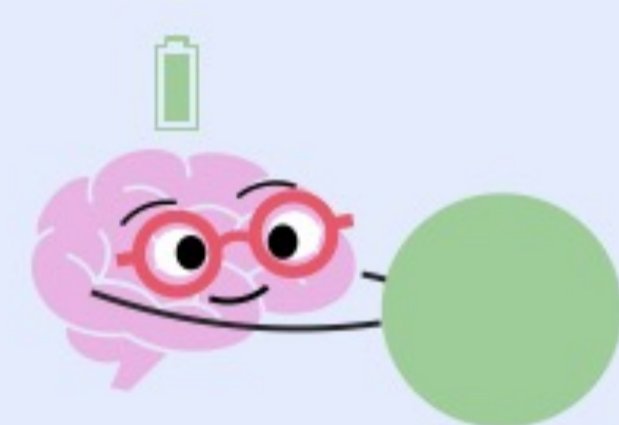
##### Current approach



- Max event-related desynchronisation (ERD) of SMRs

VS

##### Neural efficiency



- 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.

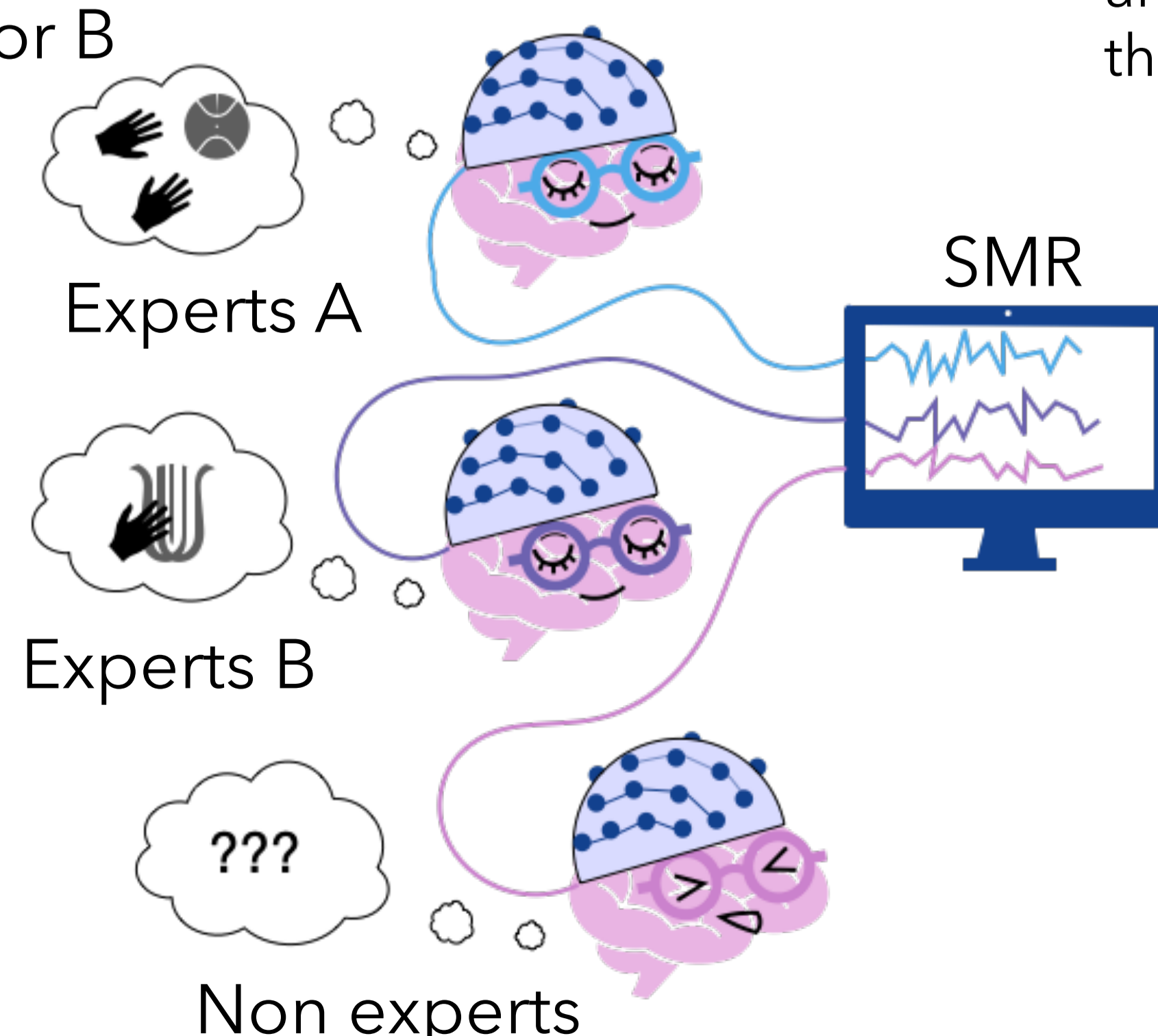
#### Participants

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

#### Protocol

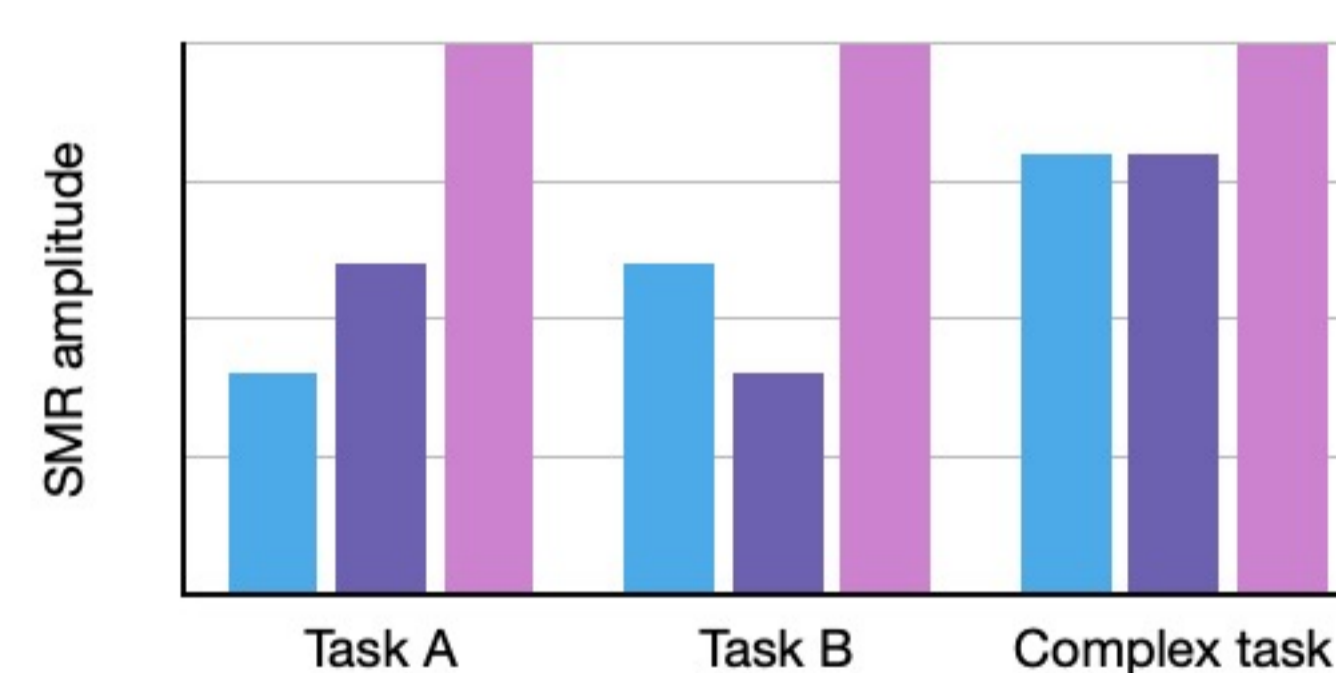
	Experts A	Experts B	Non experts
MI of task A (ex basketball specific)	N=20	N=20	N=20
MI of task B (ex harp specific)	N=20	N=20	N=20
MI of complex uncommon task	N=20	N=20	N=20

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

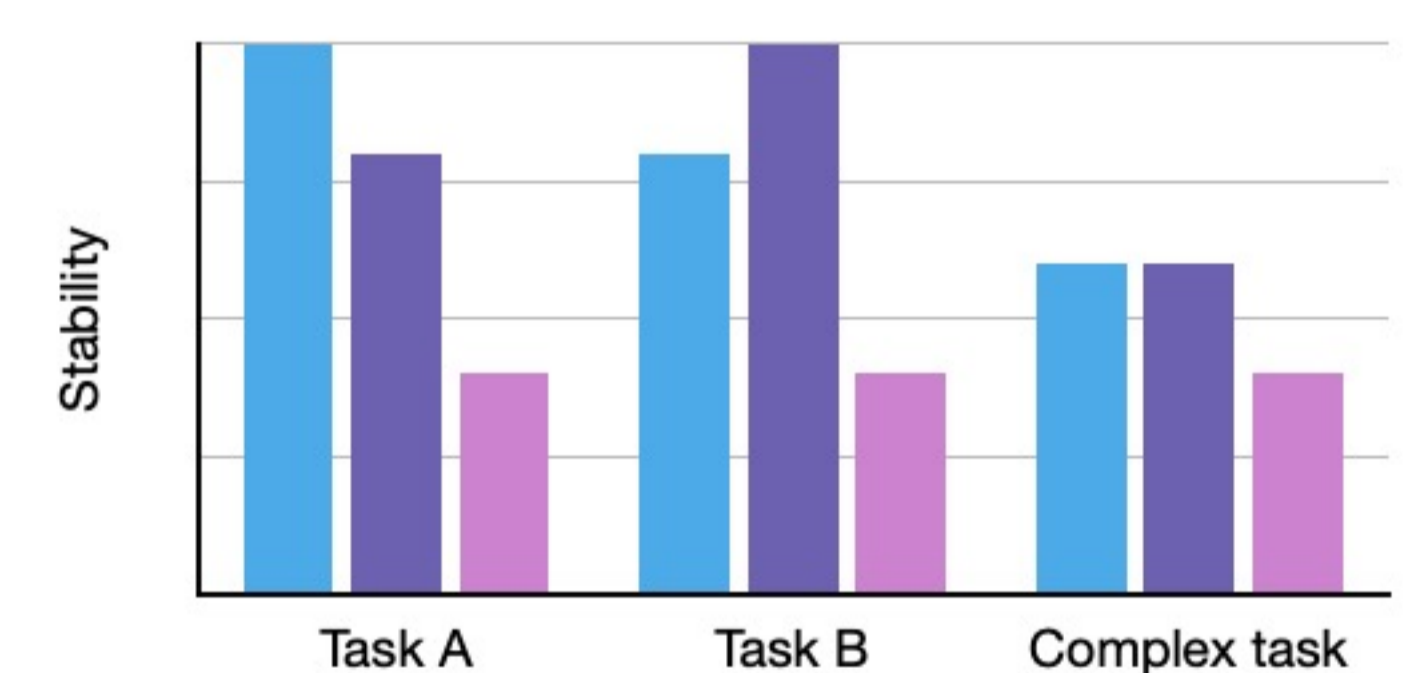


### Expected results

■ Experts A ■ Experts B ■ Non experts

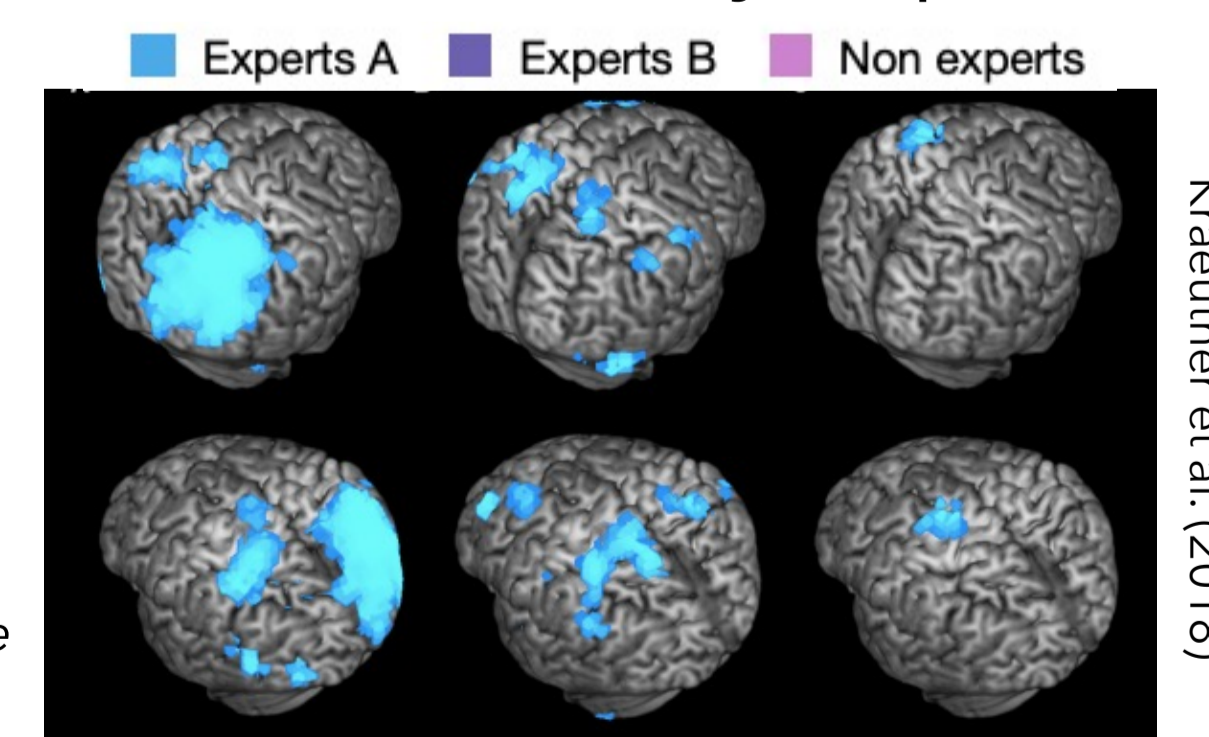


■ Experts A ■ Experts B ■ Non experts



- Experts have a better neural efficiency and stability 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?

#### References :

- [1] Guillot et al. (2008) - *NeuroImage*
- [2] Hardwick et al. (2018) - *Neuroscience & Biobehavioral Reviews* 94
- [3] Del Percio et al. (2008) - *NeuroImage* 42, n°4
- [4] Del Percio et al. (2009) - *Brain Research Bulletin* 79, n°3
- [5] Haier et al. (1988) - *Intelligence* 12
- [6] Li et al. (2021) - *Frontiers in Behavioral Neuroscience* 15
- [7] Kraeutner et al. (2018) - *European Journal of Neuroscience* 47, n°10