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# Evaluative vs explanatory neurofeedback: What is their impact on athletes' MI-NF performance and cognitive load?

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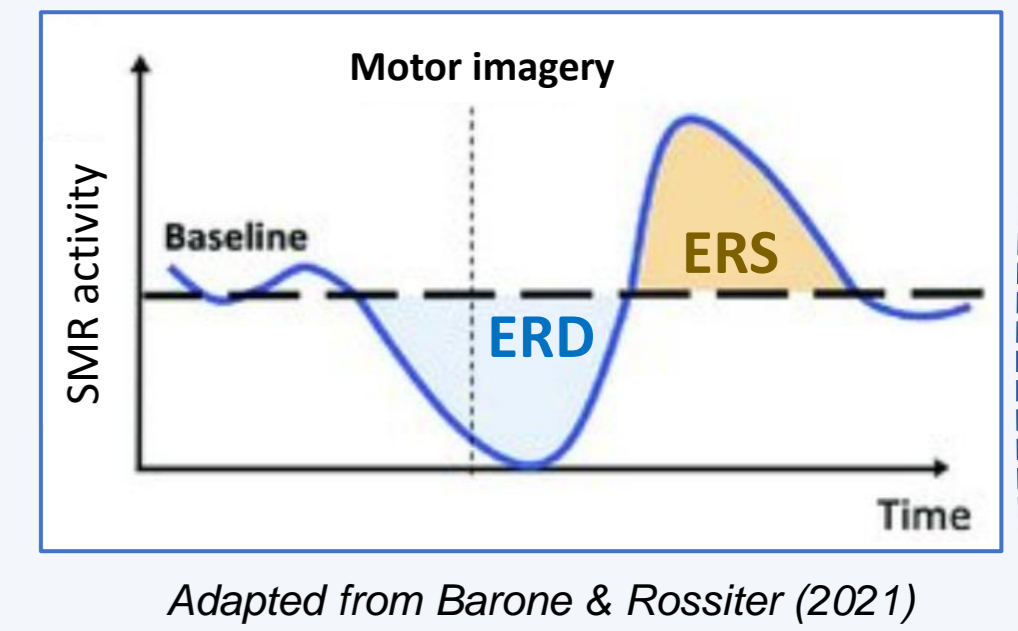
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## 1. Neurofeedback : Aim

Neurofeedback (NF) enables us to **be aware of our cerebral activity** and find strategies to modify it in order to reach the optimal cerebral activity for a specific cognitive task.

For example : *kinaesthetic motor imagery (MI) generates sensorimotor desynchronisation (SMR-ERD) in the sensorimotor cortex.*



## 2. Neurofeedback : Limits

**Mostly not ecological and abstract.**

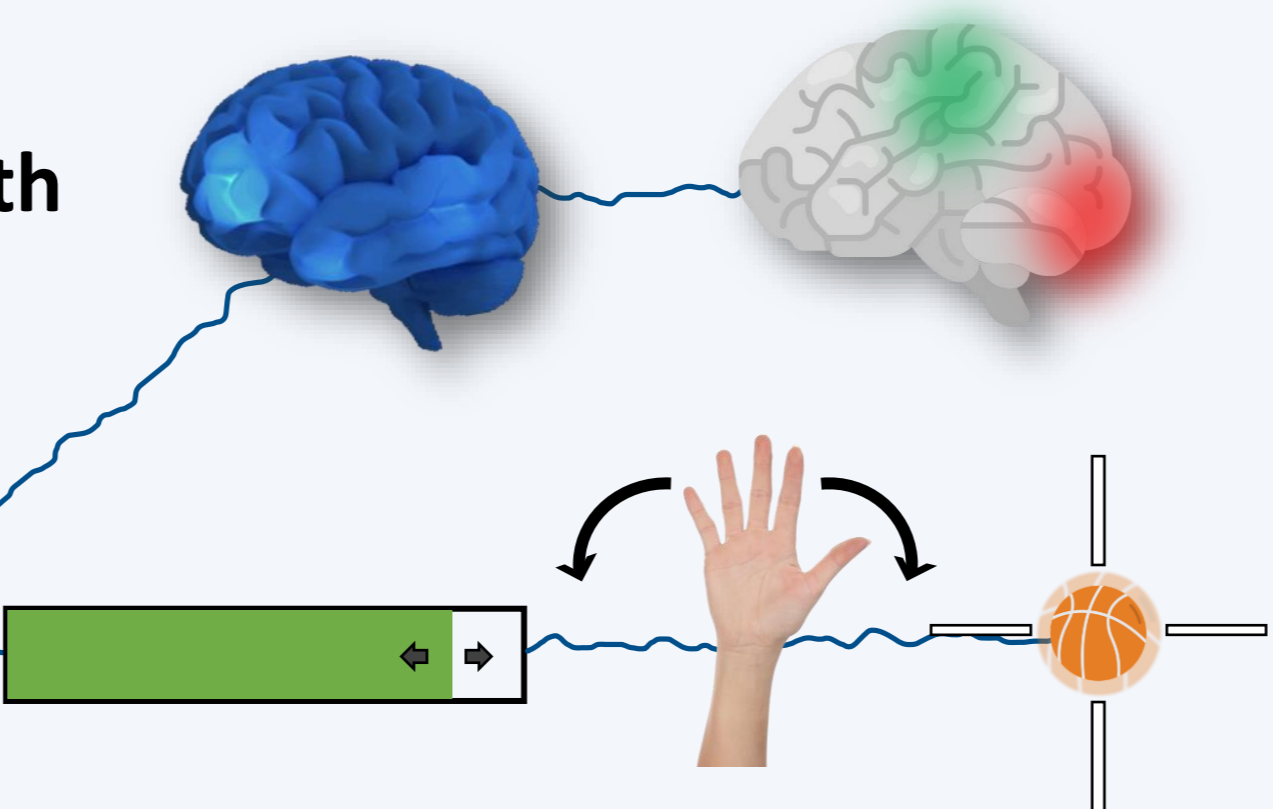
Lack of usability<sup>[1]</sup>, generating:

- Lack of transferability in real training environments
- Lack of motivation and usability

NF trainings are **almost exclusively designed with evaluative feedback.**

Conceptual reviews declare that <sup>[2,3,4,5]</sup> :

- **Explanatory feedback** is suited for **novice NF users**
- **Evaluative feedback** is suited for **expert users**



## 3. How can we improve NF training design?

Using **virtual reality (VR)** to :

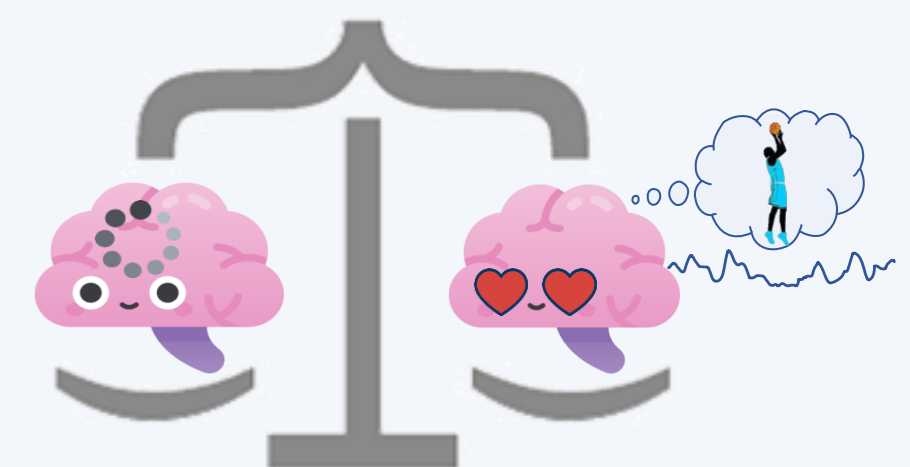
- Immerse athletes in their habitual training environment
- Increase their motivation, embodiment and NF performances <sup>[6,7,8]</sup>

Using the **most suited feedback for each user** depending on their **level of expertise** (evaluative, explanatory, both)

## 4. Aim of our study

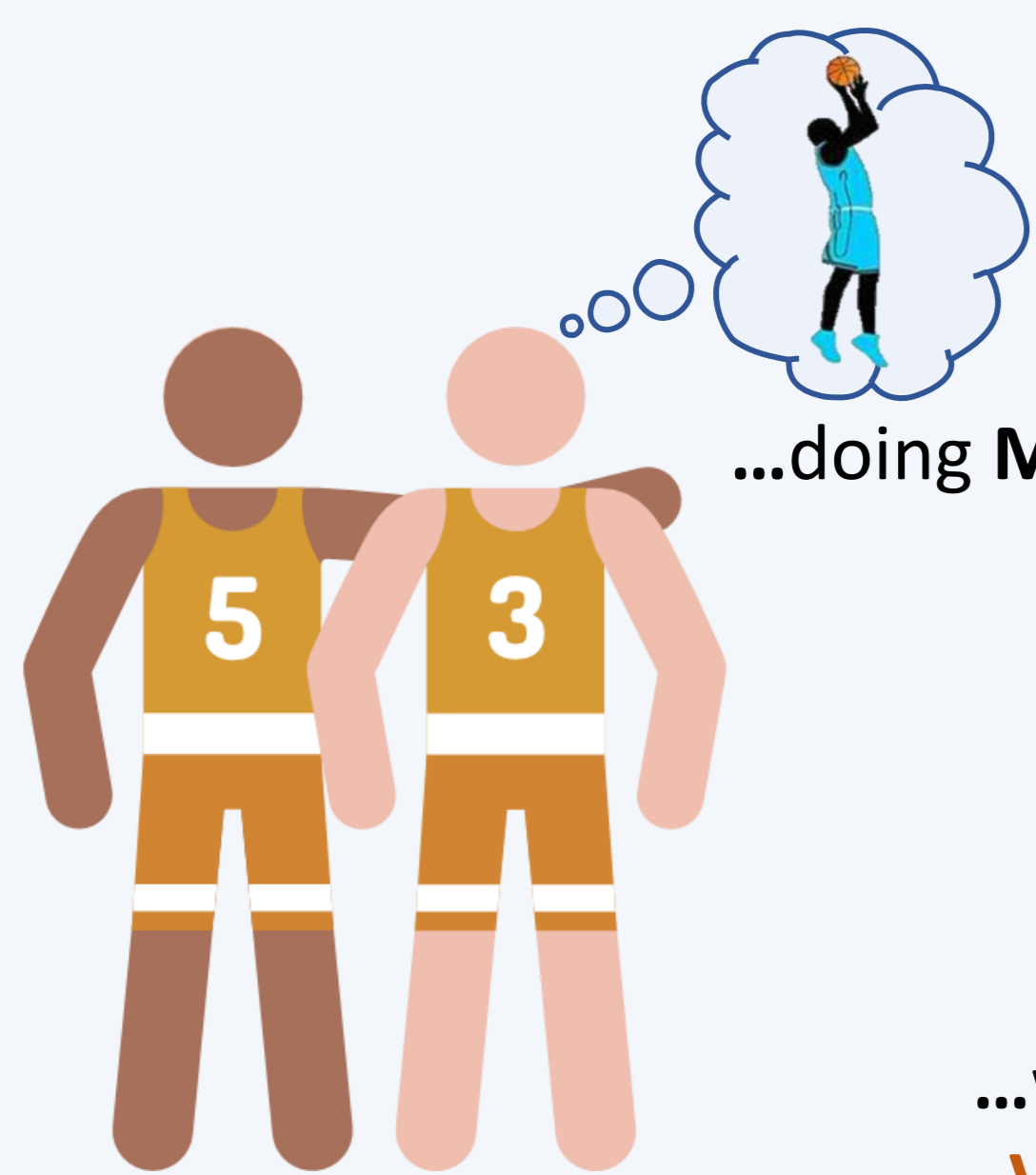
Based on aforementioned studies results, we will use VR to :

Identify, for each athlete, neurofeedback characteristics that provide the most relevant information to maximise usability and performance without overloading the athlete.

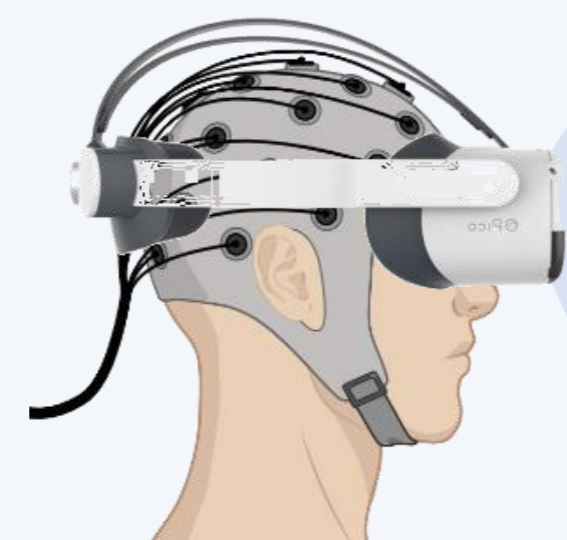


## 5. Experimental approach

**44 basketball players** of different levels (of sport, MI and NF expertise)...



...doing **MI of a specific basketball task...** (free throw)



...while using :

- **VR** (ecological environment + motivation)
- **EEG** (NF + SMR recording)
- **Eye tracking system** (visual focus on feedback) ...



...in presence/absence of explanatory/evaluative feedback,...

...and answering **questionnaires** beforehand and afterwards.

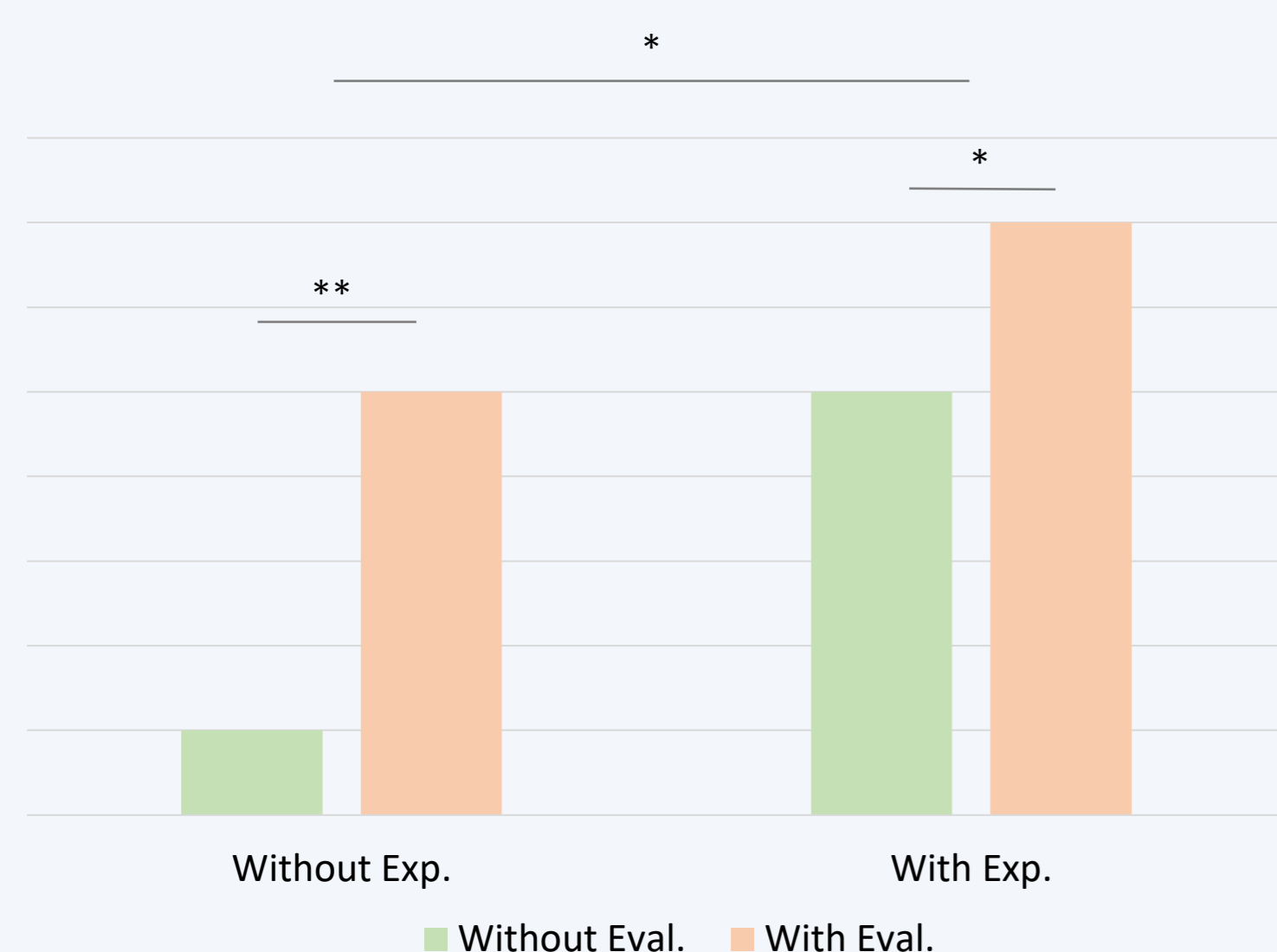
- **Personality** (*BigFive*)
- **MI expertise** (*MIQ-3f + IUQ*)
- **Cognitive Load** (*NASA-TLX*)
- **Usability**

### Design:

- **Within-subject** paradigm
- Independent variables
  - **Evaluative NF** (presence/absence)
  - **Explanatory NF** (presence/absence)
- Dependent variables
  - **MI-NF performance** (*SMR-ERD*)
  - **Usability**
  - **Cognitive load**

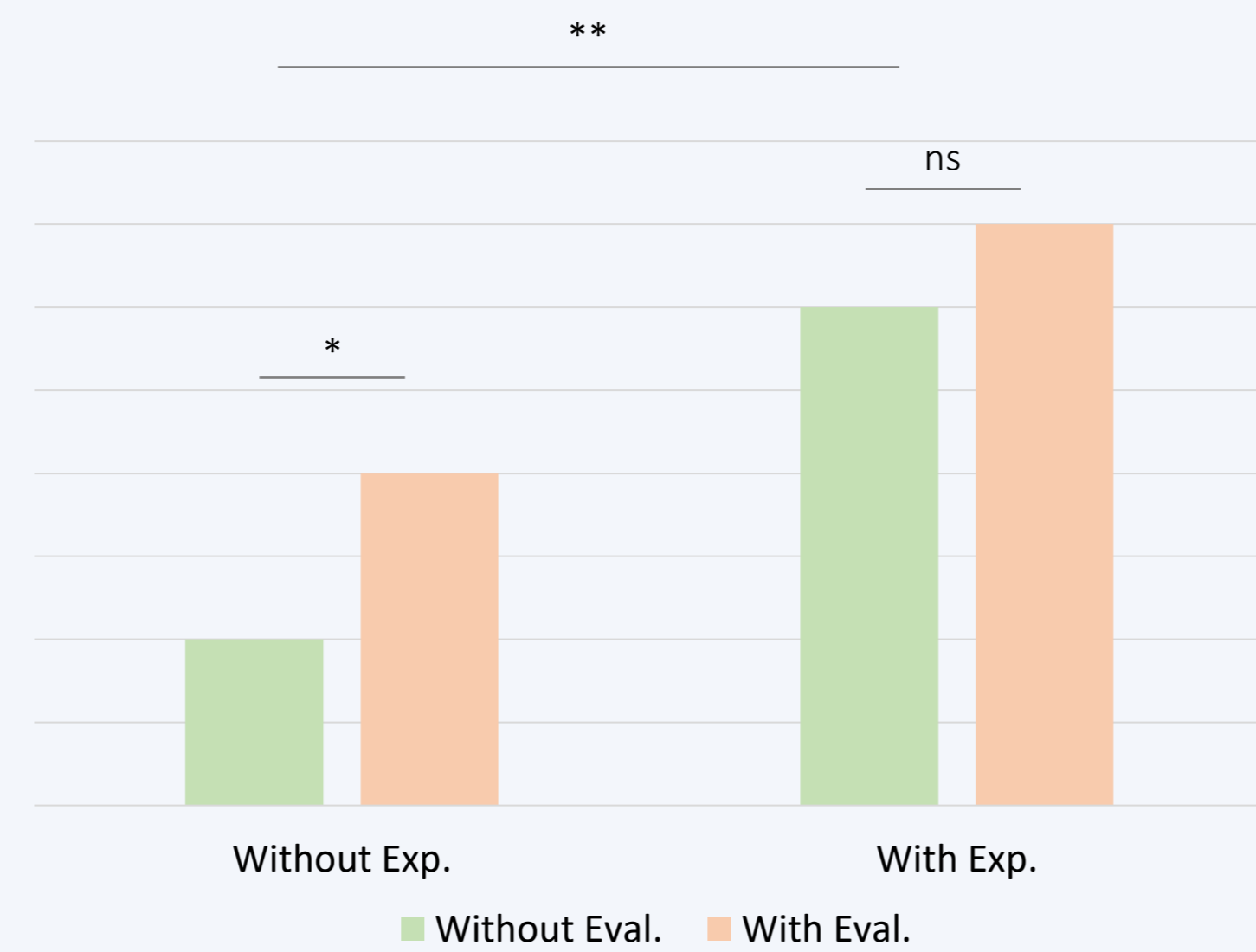
## 6. Expected results

### MI-NF Performance



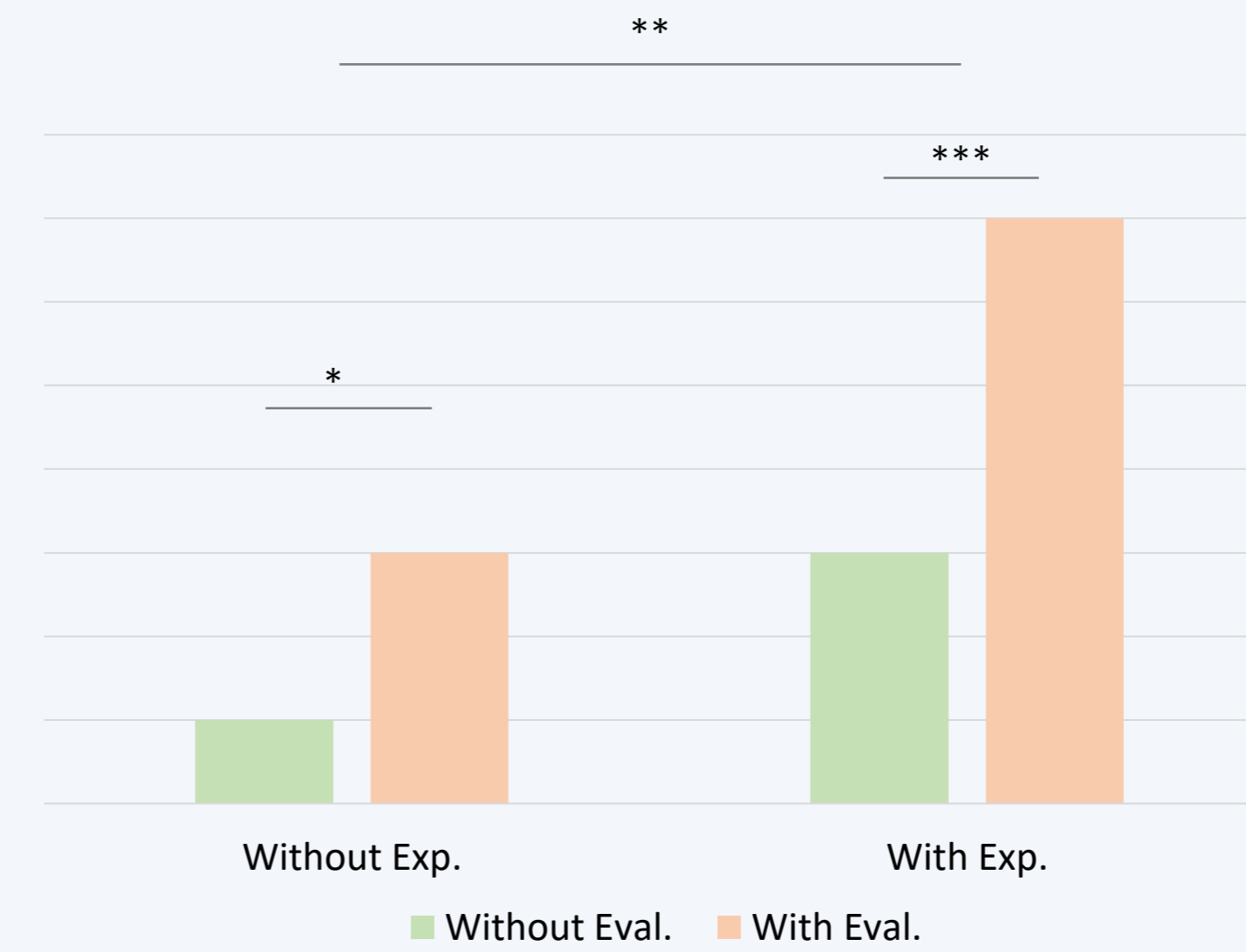
- Better MI-NF performance with explanatory NF than without.
- Better MI-NF performance with evaluative NF than without it, what is more when there is no explanatory NF.

### Usability



- Better usability with explanatory NF than without.
  - Better usability with evaluative NF than without, only when there is no explanatory NF.
- In other words, explanatory NF is sufficient to reach a high level of usability so in its presence, evaluative NF doesn't have any influence.*

### Cognitive Load



- Higher cognitive load with explanatory NF than without.
- Higher cognitive load with evaluative NF than without it, what is more when there is explanatory NF.

Globally, we expect the best MI-NF performances and usability with both explanatory and evaluative feedback combined, despite a high associated cognitive load

## 7. Let's talk

- What kind of feedback is the most suitable for users to estimate their NF performance?
- What factors are to be considered in priority to maximise NF learning? E.g., are high MI performances a reliable predictor of long-term learning if associated with high workload and low usability?
- What neurophysiological pattern(s) should be reinforced during MI-based NF trainings?

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