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

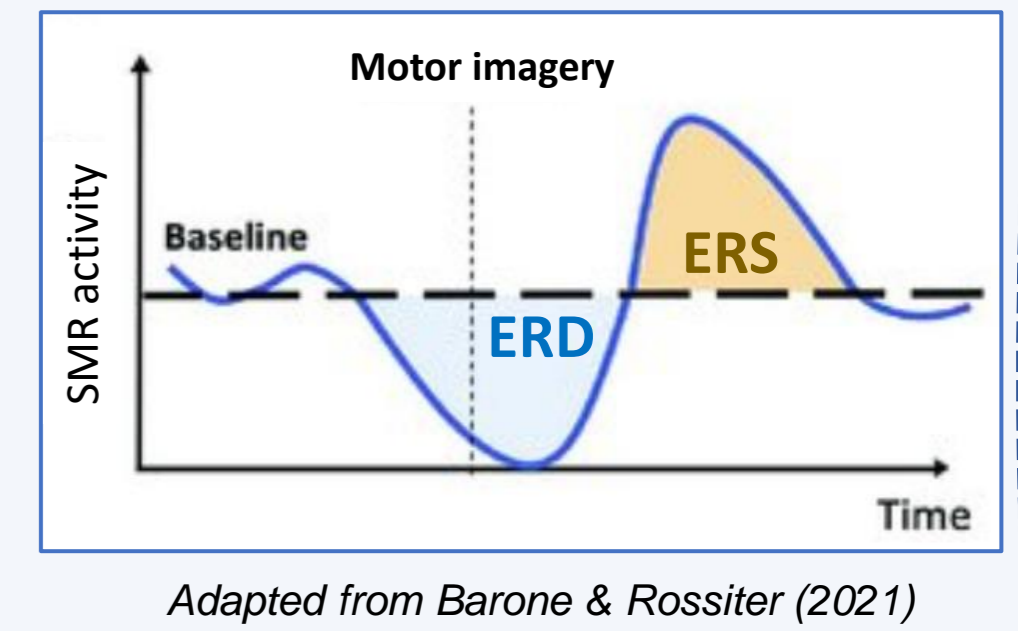
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1. Neurofeedback : Aim

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.

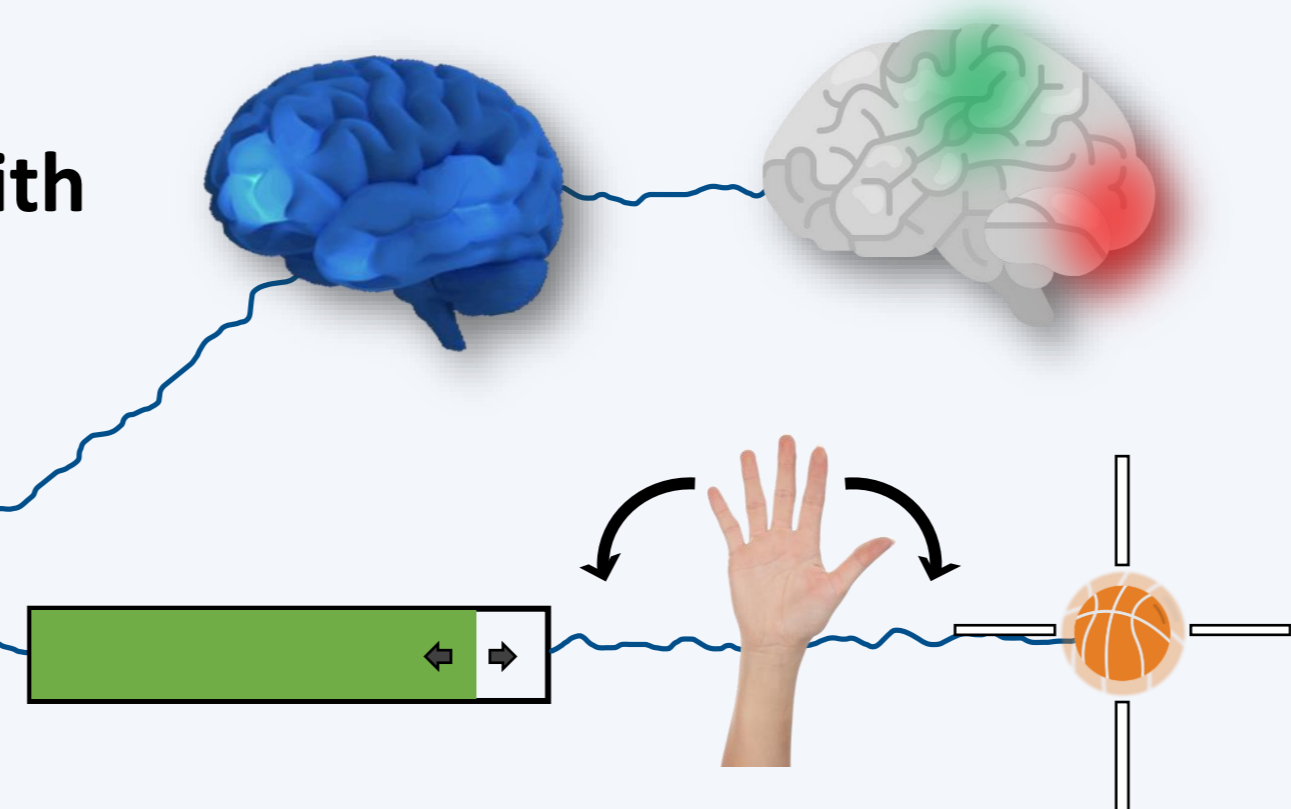
Lack of usability^[1], generating:

- 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 ^[2,3,4,5] :

- **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 :

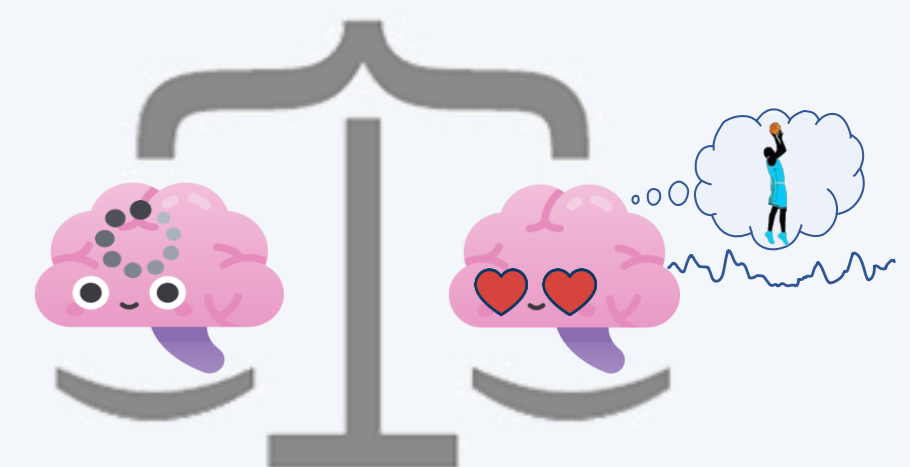
- Immerse athletes in their habitual training environment
- Increase their motivation, embodiment and NF performances ^[6,7,8]

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

4. Aim of our study

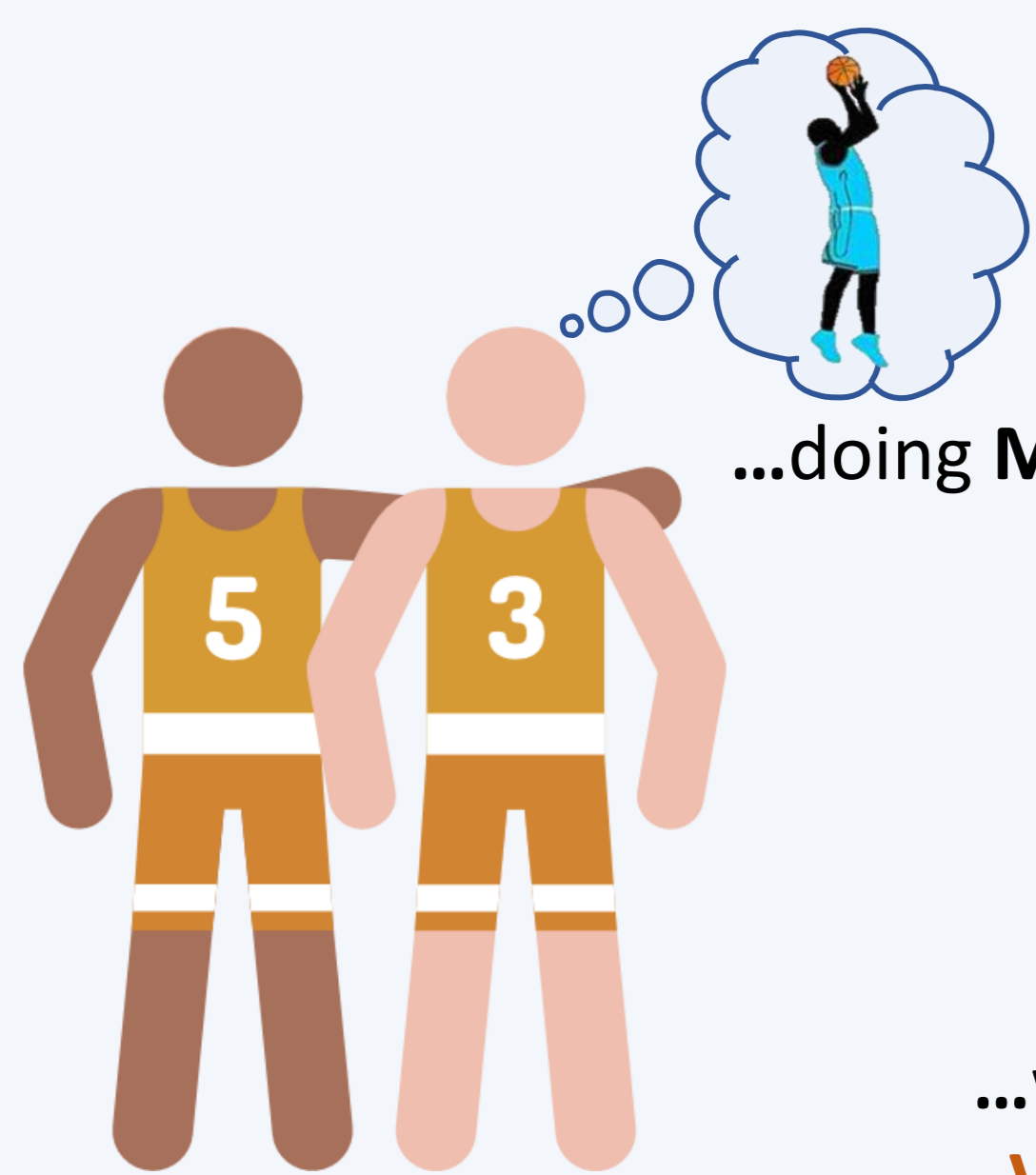
Based on aforementioned studies results, we will use VR to :

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

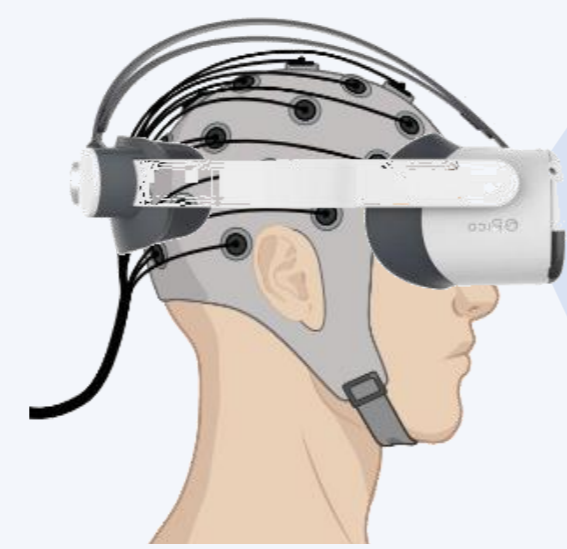


5. Experimental approach

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.

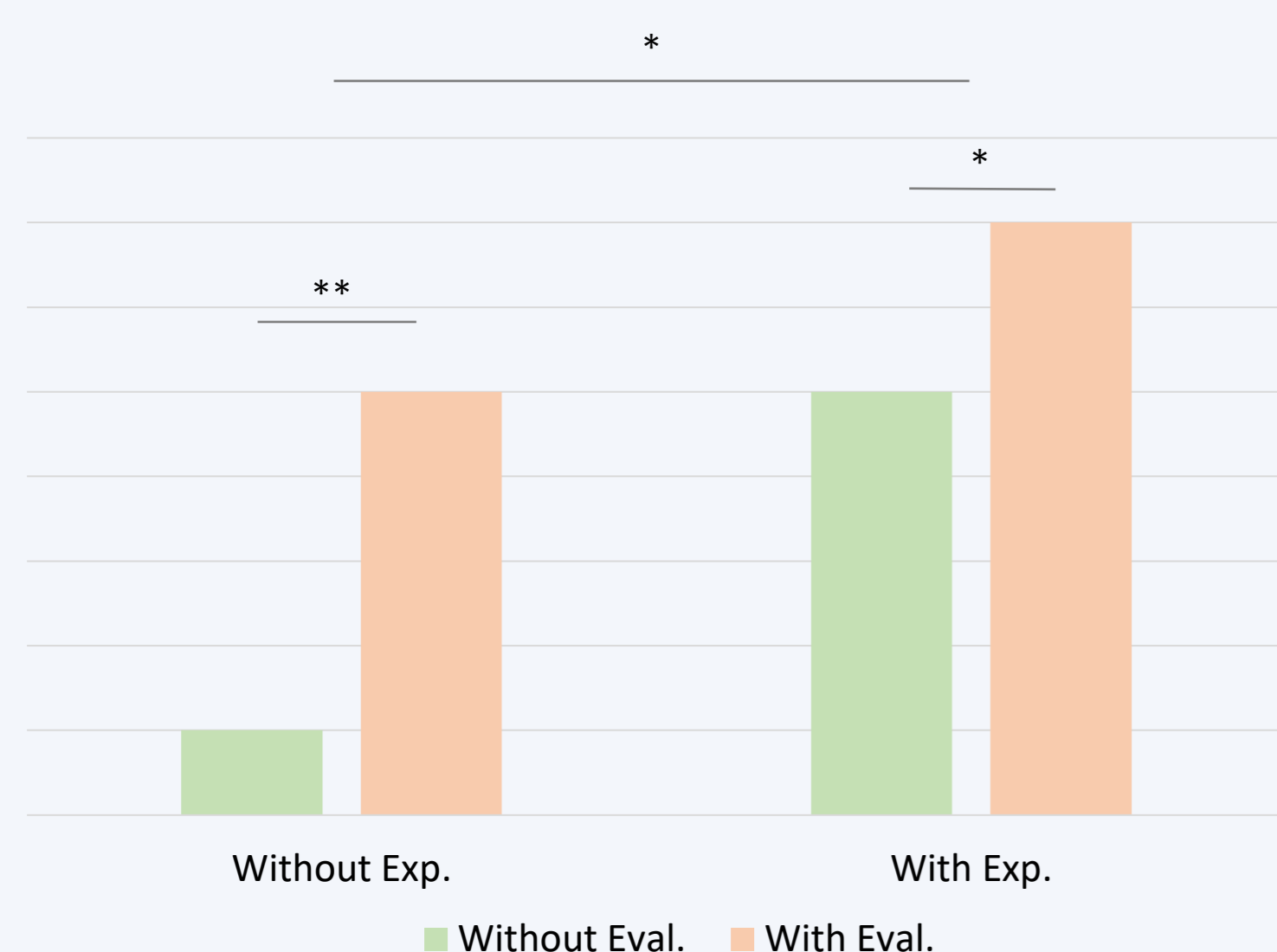
- **Personality** (*BigFive*)
- **MI expertise** (*MIQ-3f + IUQ*)
- **Cognitive Load** (*NASA-TLX*)
- **Usability**

Design:

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

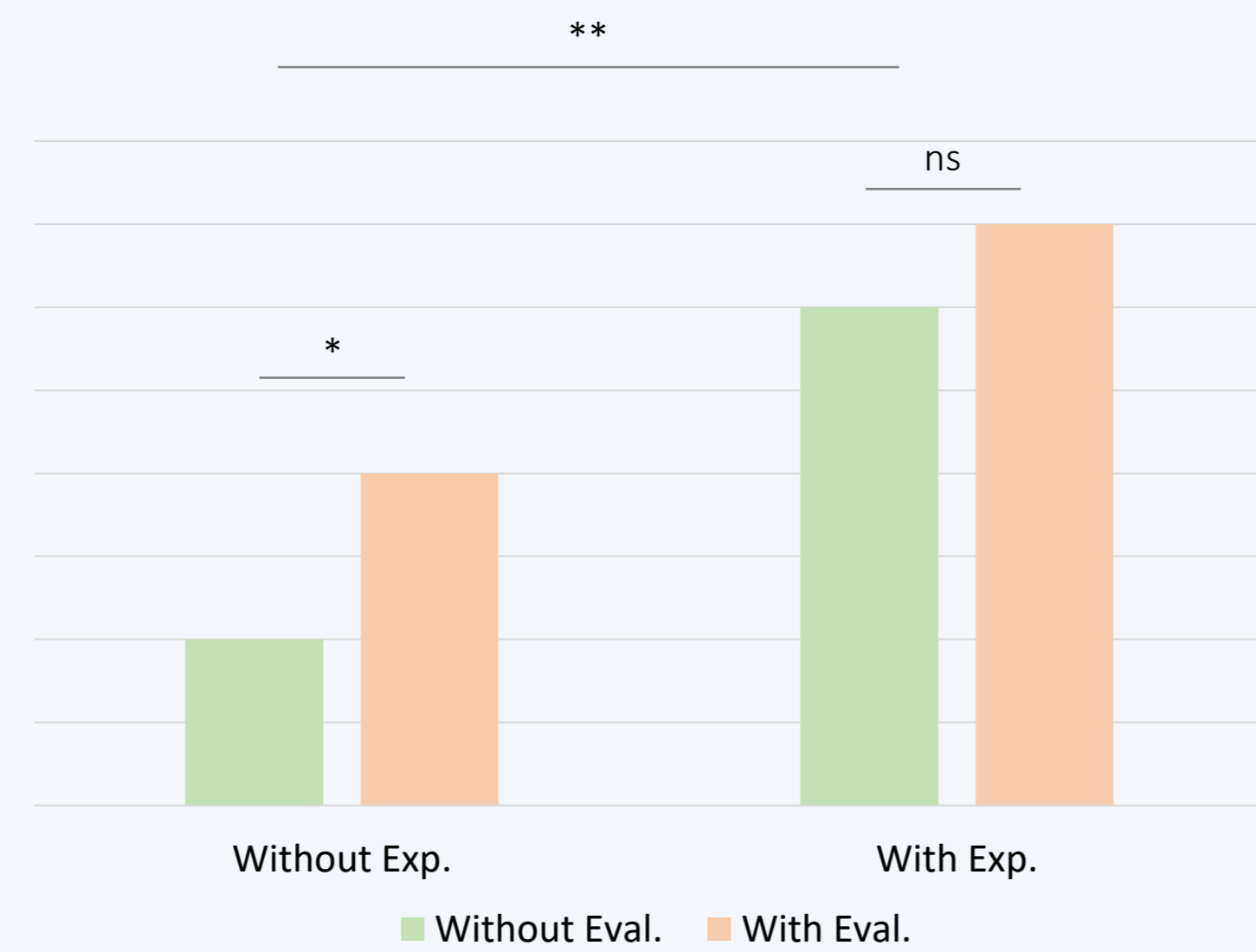
6. Expected results

MI-NF Performance



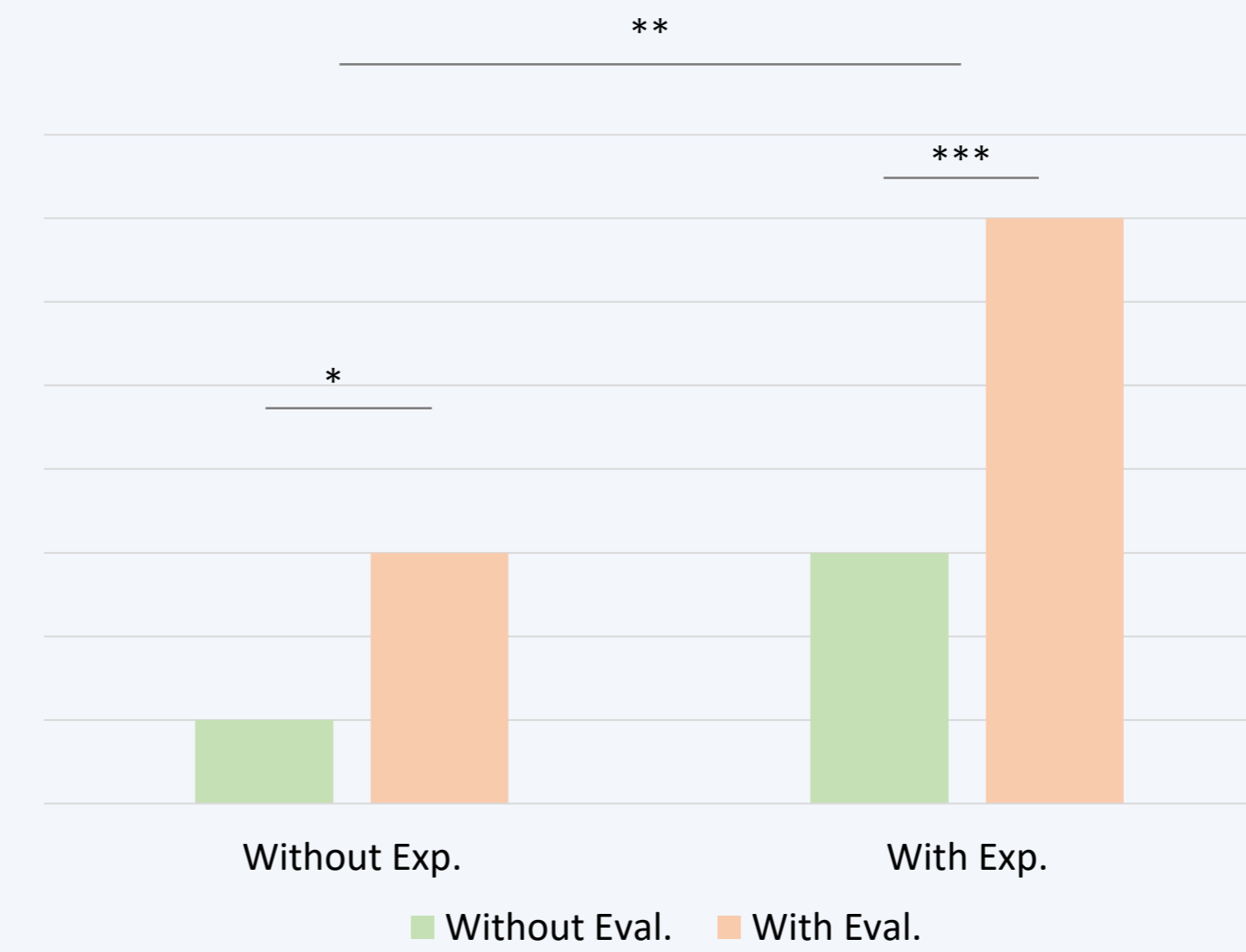
- Better MI-NF performance with explanatory NF than without.
- Better MI-NF performance with evaluative NF than without it, what is more when there is no explanatory NF.

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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