A Collaborative BCI Trained to Aid Group Decisions in a Visual Search Task Works Well with Similar Tasks

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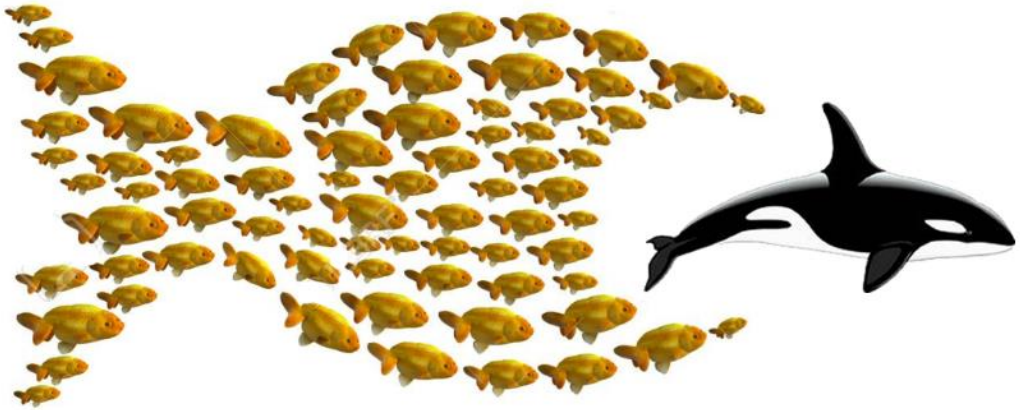
Outline

- Background
- Contributions
- Experimental work
- Results
- Conclusions

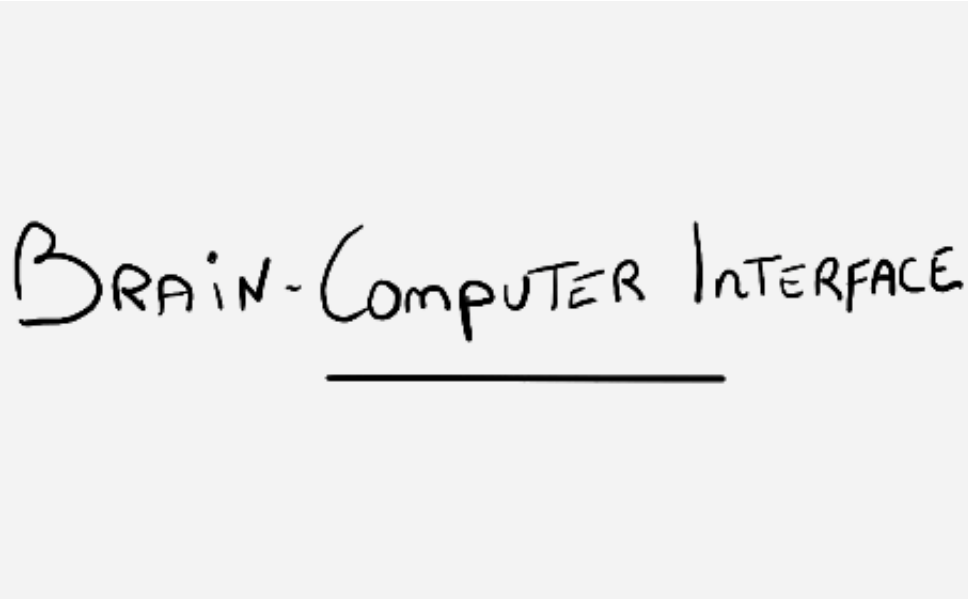
Group Decision Making

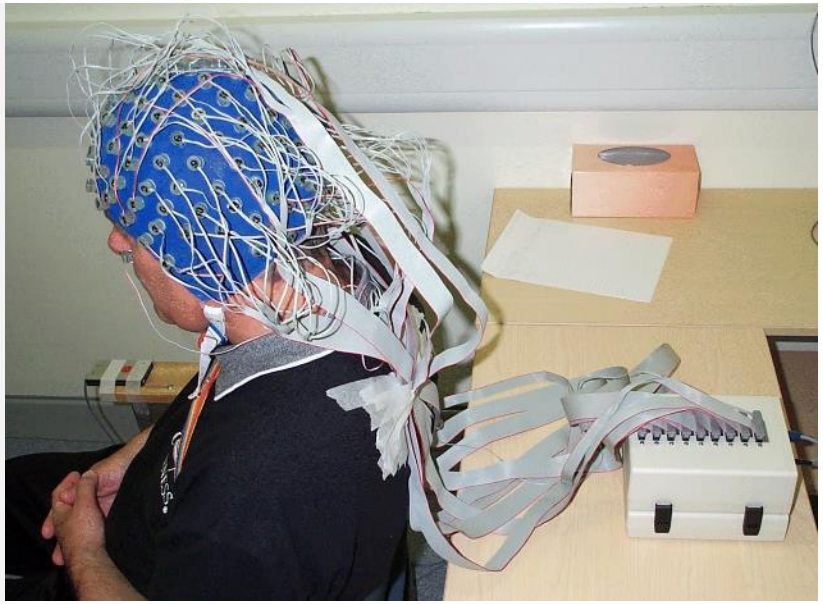
- Augmented capabilities and perception
- Vital for **critical decisions** (e.g., defence, health and finance)
- Traditionally require **large groups**



Brain-Computer Interfaces (BCIs)

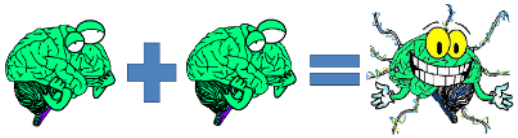
- Convert brain signals to commands
- Traditionally used by disabled
- Recently applied to **human enhancement** and **neuroergonomics**





Collaborative BCIs (cBCIs)

Use data from **multiple brains** to improve BCI performance



BCIs

- Low accuracy
- Low speed

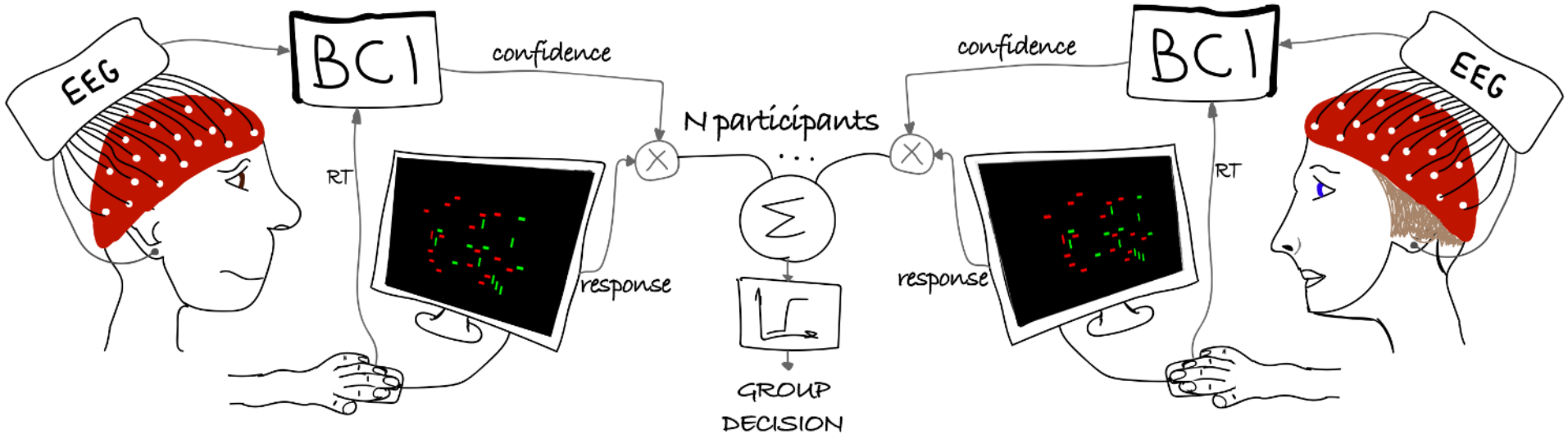
Groups

- Leadership bias
- Time constraints

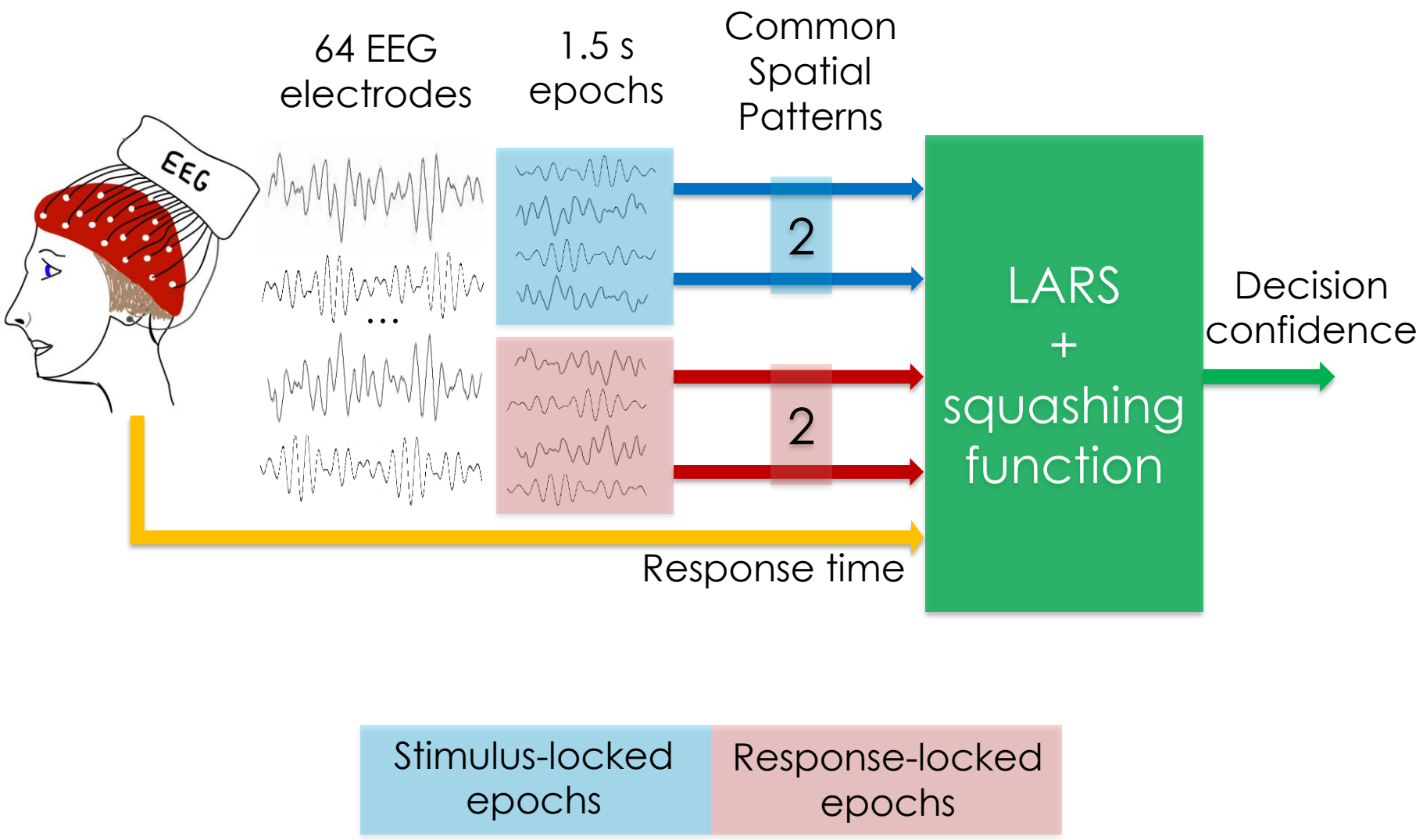
Collaborative BCIs

Hybrid cBCIs for Group Decision Making

- Users report individual decisions (hybrid)
- Each BCI predicts the **decision confidence**, i.e., the probability of a decision to be correct
- **Weighted majority** to make group decisions

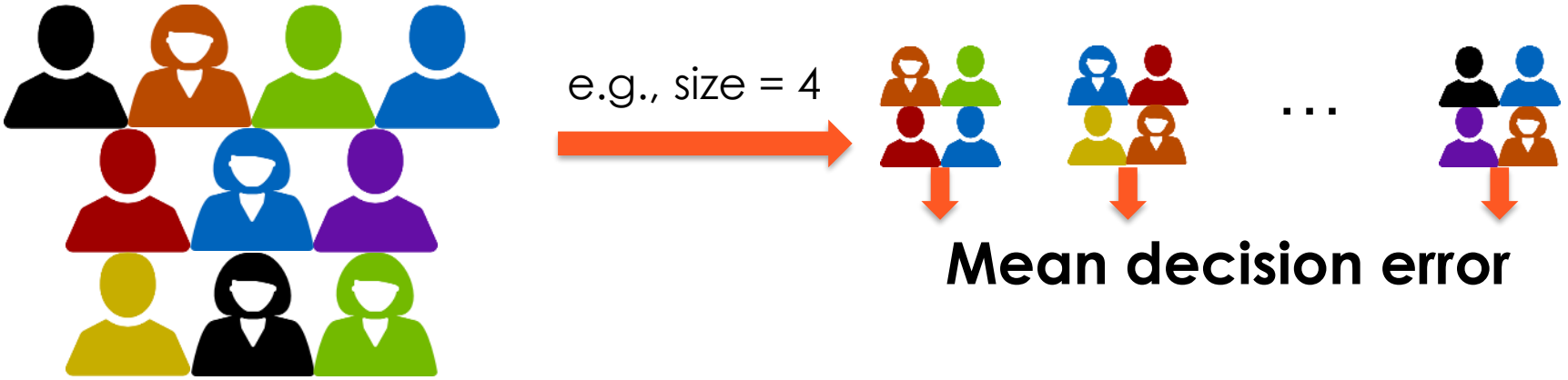


Decision Confidence Estimation



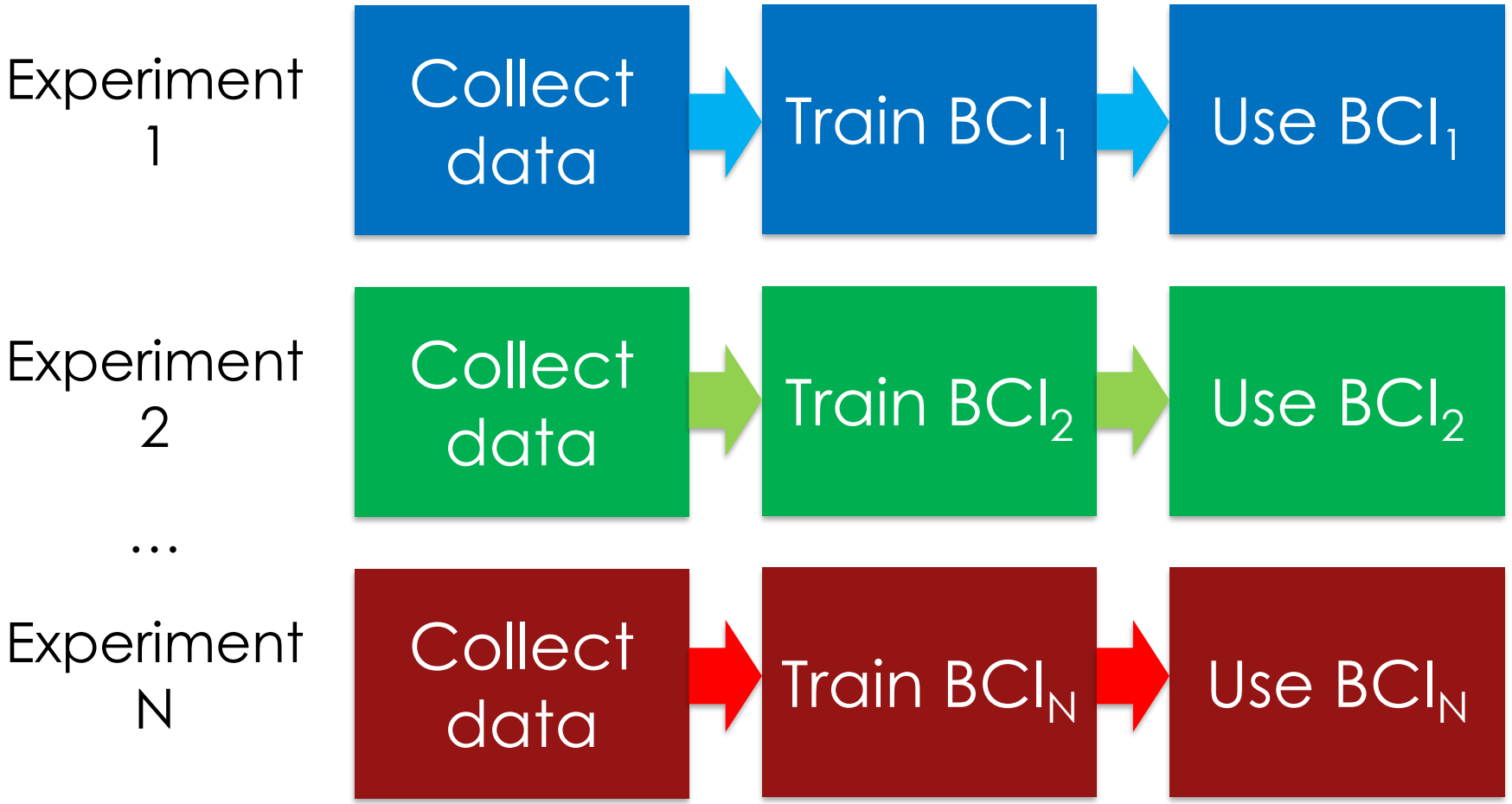
Group Simulation

- Data recorded separately
- **Participants combined offline** in groups of increasing size
- Error rates computed across **all possible groups** of each size



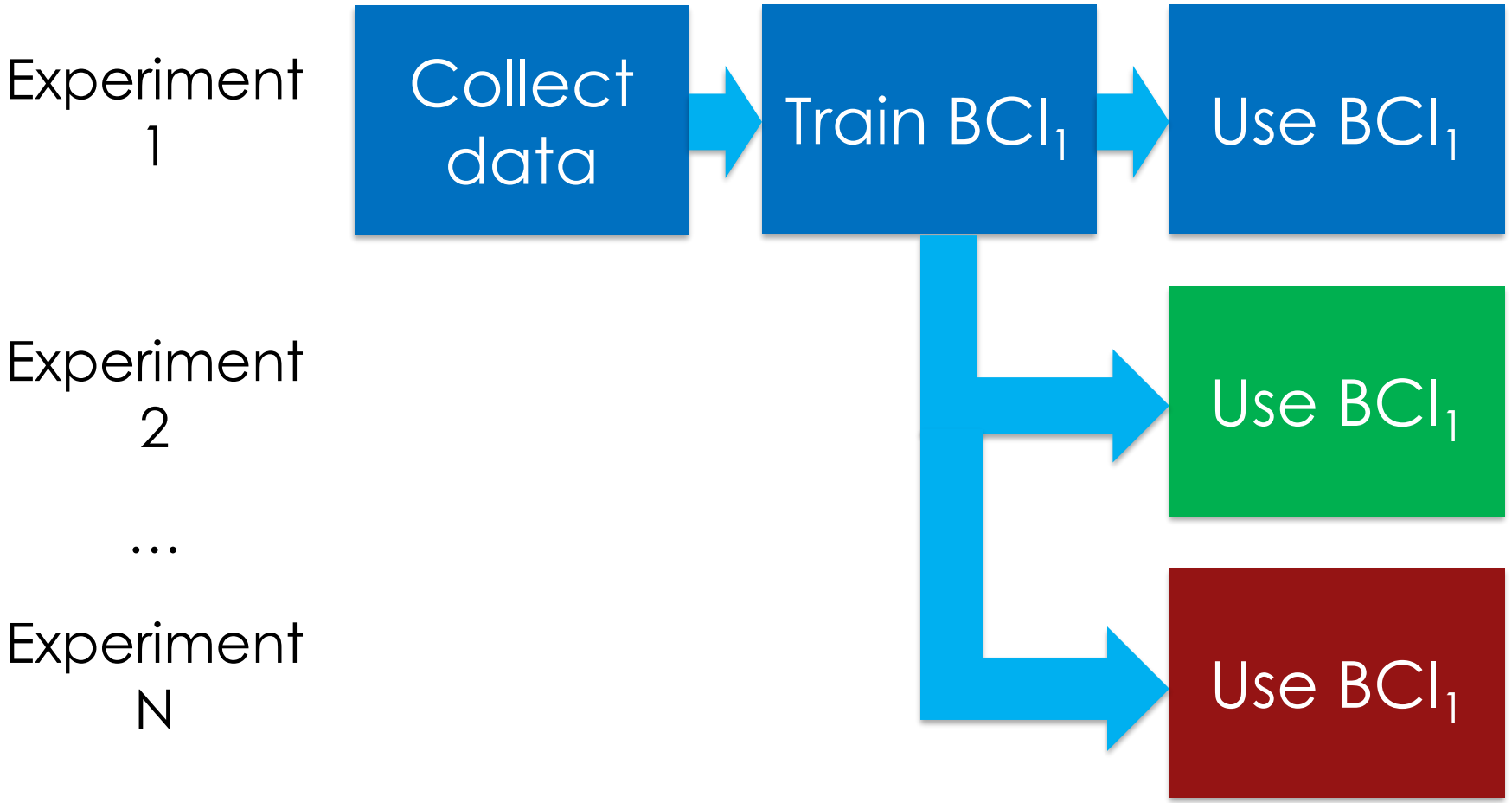
Supervised Machine Learning BCI

Classic approach: **one BCI per experiment**



Transfer Learning in BCI

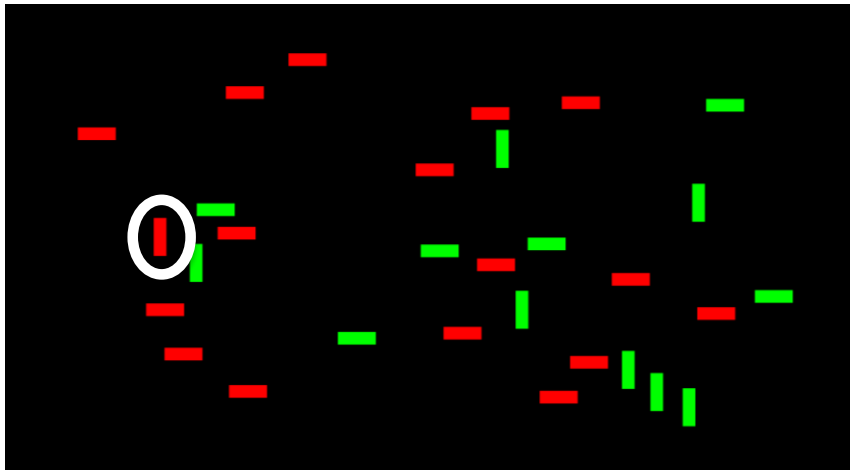
Protocol tested in this paper



Experiments

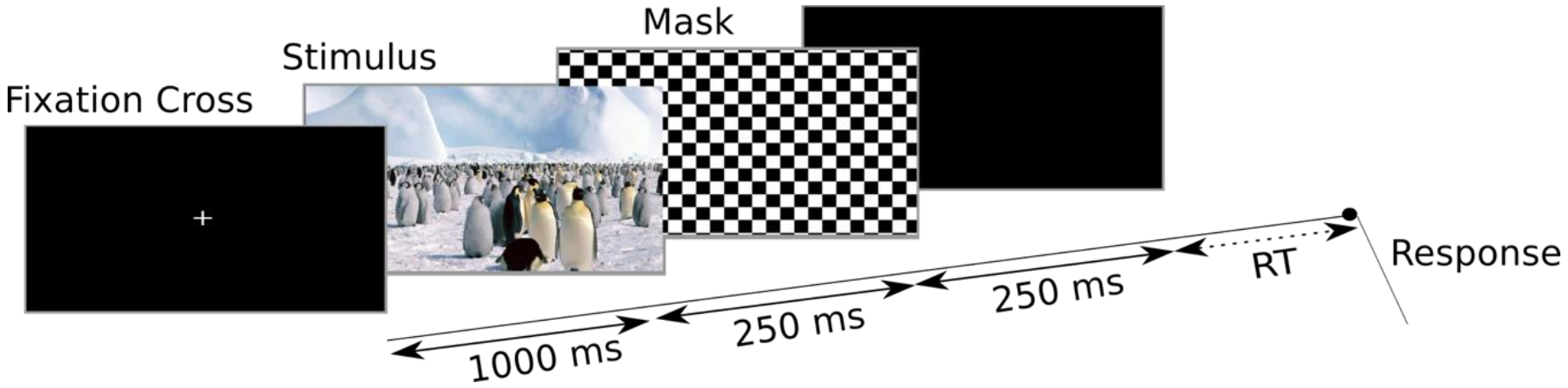
Two similar **visual search** experiments:

- Experiment 1: finding a **vertical red bar** in a display of 40 coloured bars
- Experiment 2: finding a **polar bear** in a picture full of penguins

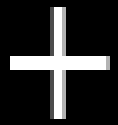


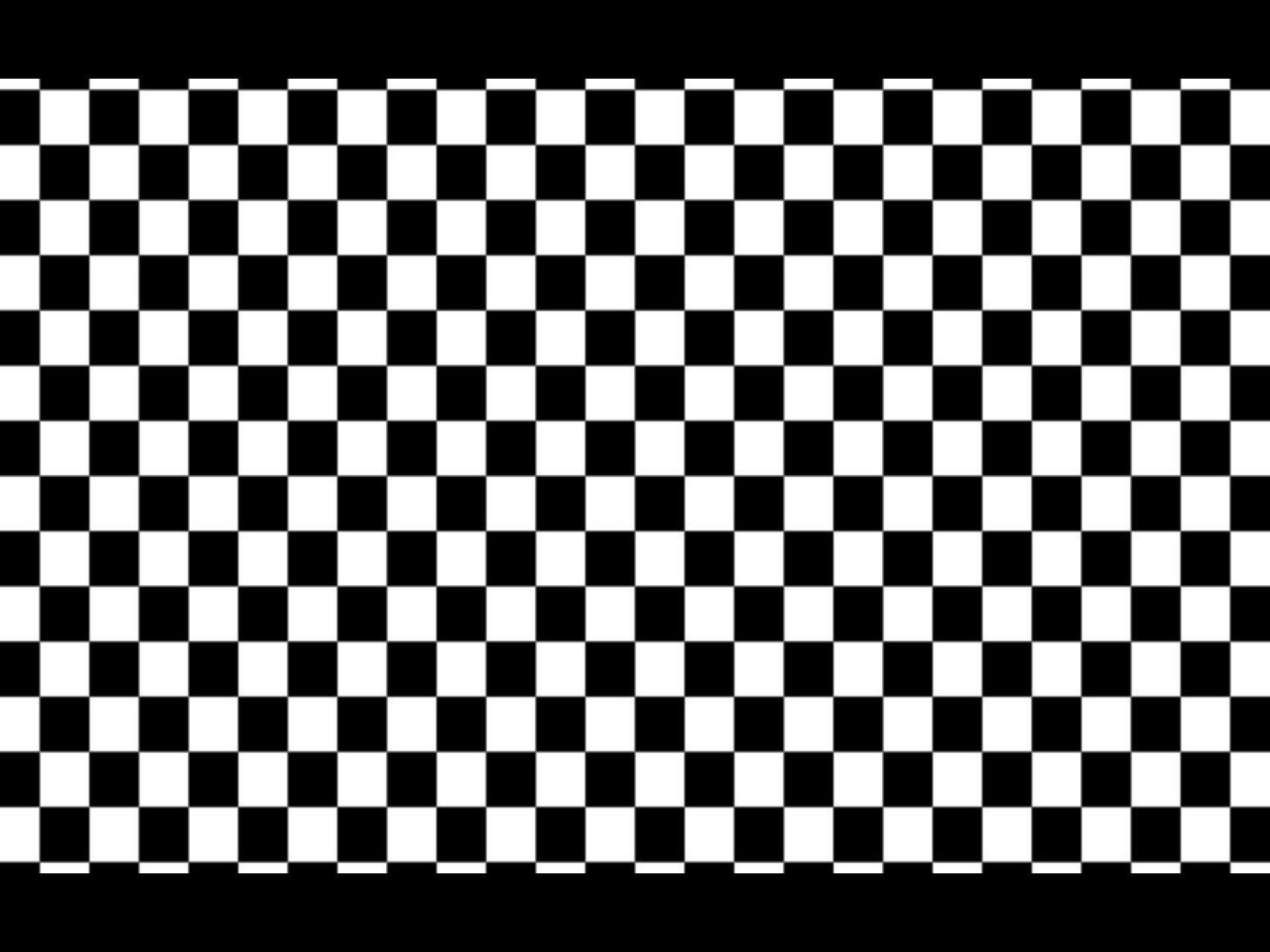
Similar Protocol

- **320 trials** split in 8 blocks
- Stimulus shown for **250 ms**
- **10 participants** performing the two experiments in counterbalanced order



Are you ready to try Experiment 2?

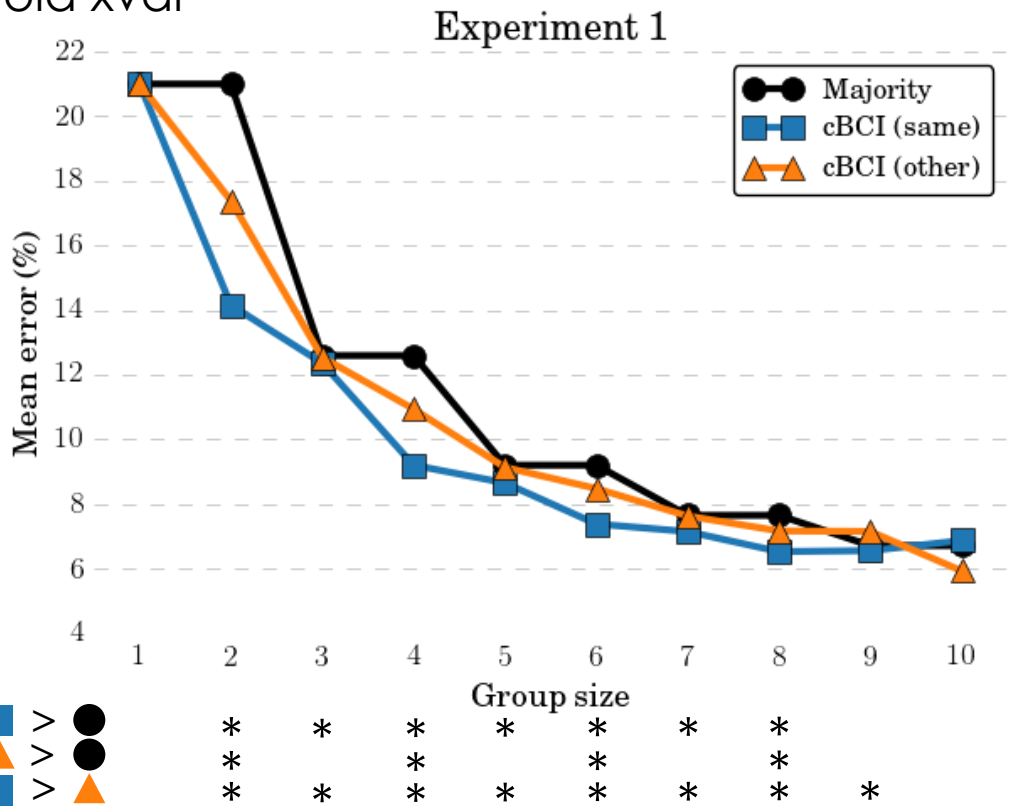




Have you seen a polar bear?

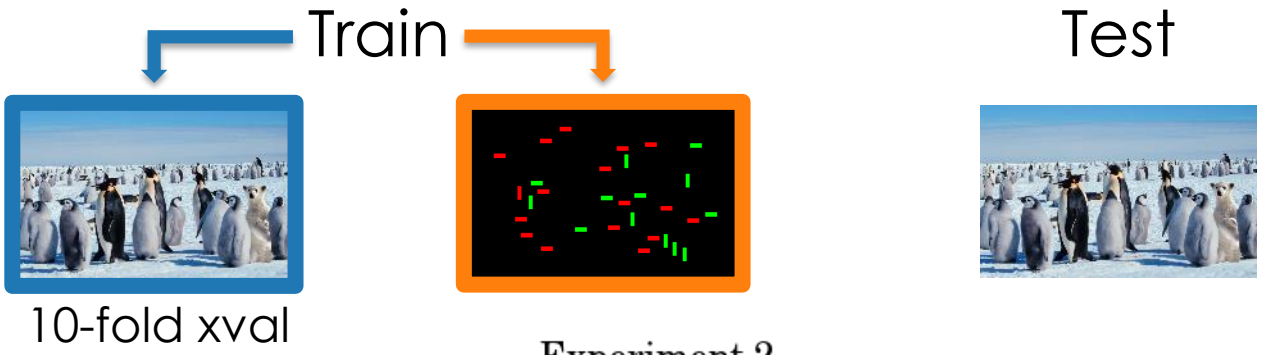
Can you see it now?

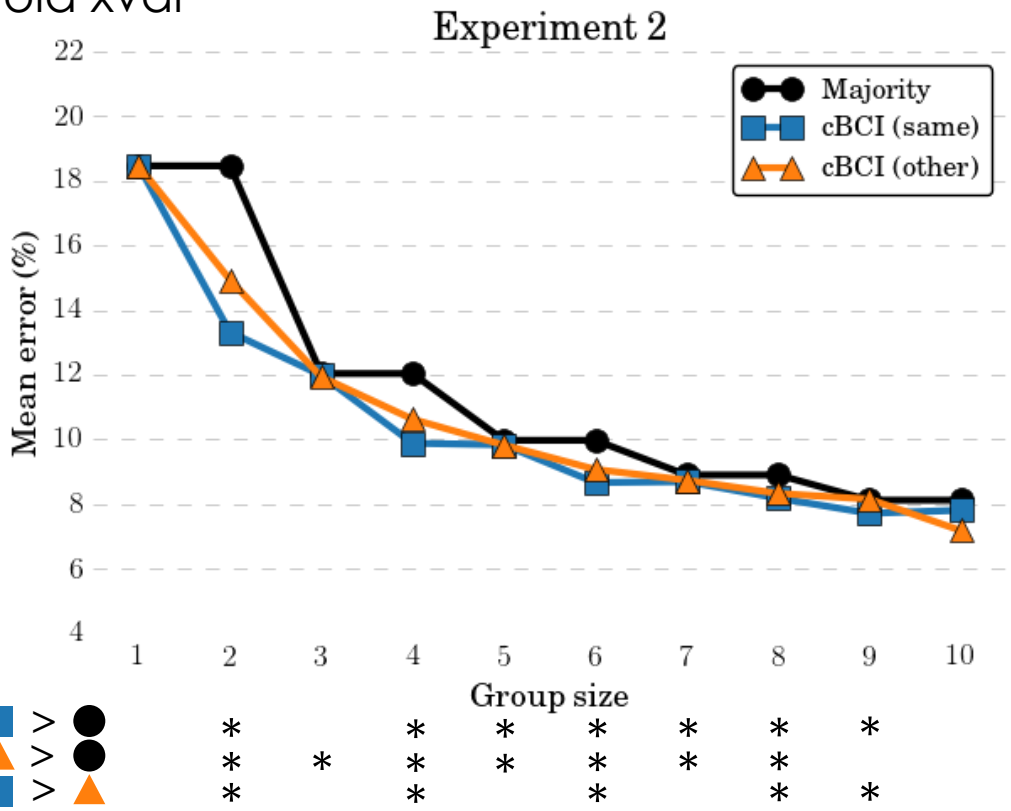
Results – Experiment 1



Wilcoxon signed-rank test $p < 0.05$

Results – Experiment 2





Wilcoxon signed-rank test $p < 0.05$

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Conclusions

- **Hybrid cBCIs significantly improve** group decisions over traditional non-BCI groups
- **Transfer learning** allows to reduce training times without major losses in performance
- The **optimal solution** is to **have one BCI per experiment** and **even-sized groups**

- **Future work**: use transfer learning in other domains, e.g., multisensory perception

Questions?

Thank you!

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