Reducing barriers to communication technologies: New performance metrics and training methods for brain-computer interfaces
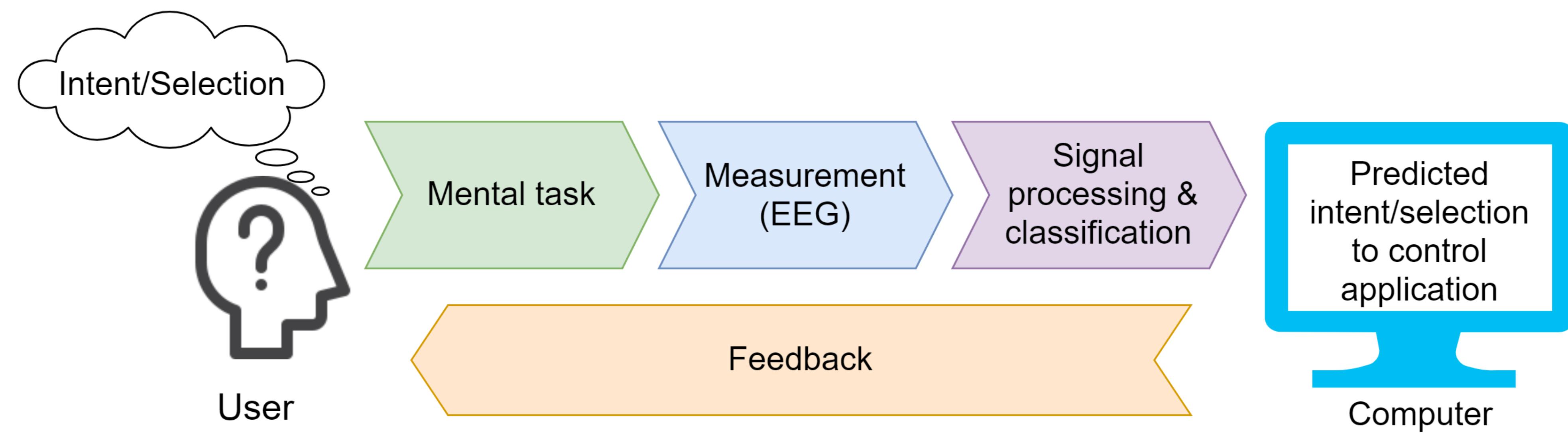
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What is a brain-computer interface (BCI)?

A BCI is a technology designed to enable users to control computers using only brain signal patterns associated with different mental tasks

BCI inefficiency: How do you think?

Unfortunately, current BCIs **do not work** for a large proportion of potential users[1,2]

Why? Everyone's brain and mental task approach is different, some need **guided training and practice** to find an approach that works[1,3]

However, current BCI-user training approaches often **fail to effectively promote skill learning**[1,3,4]
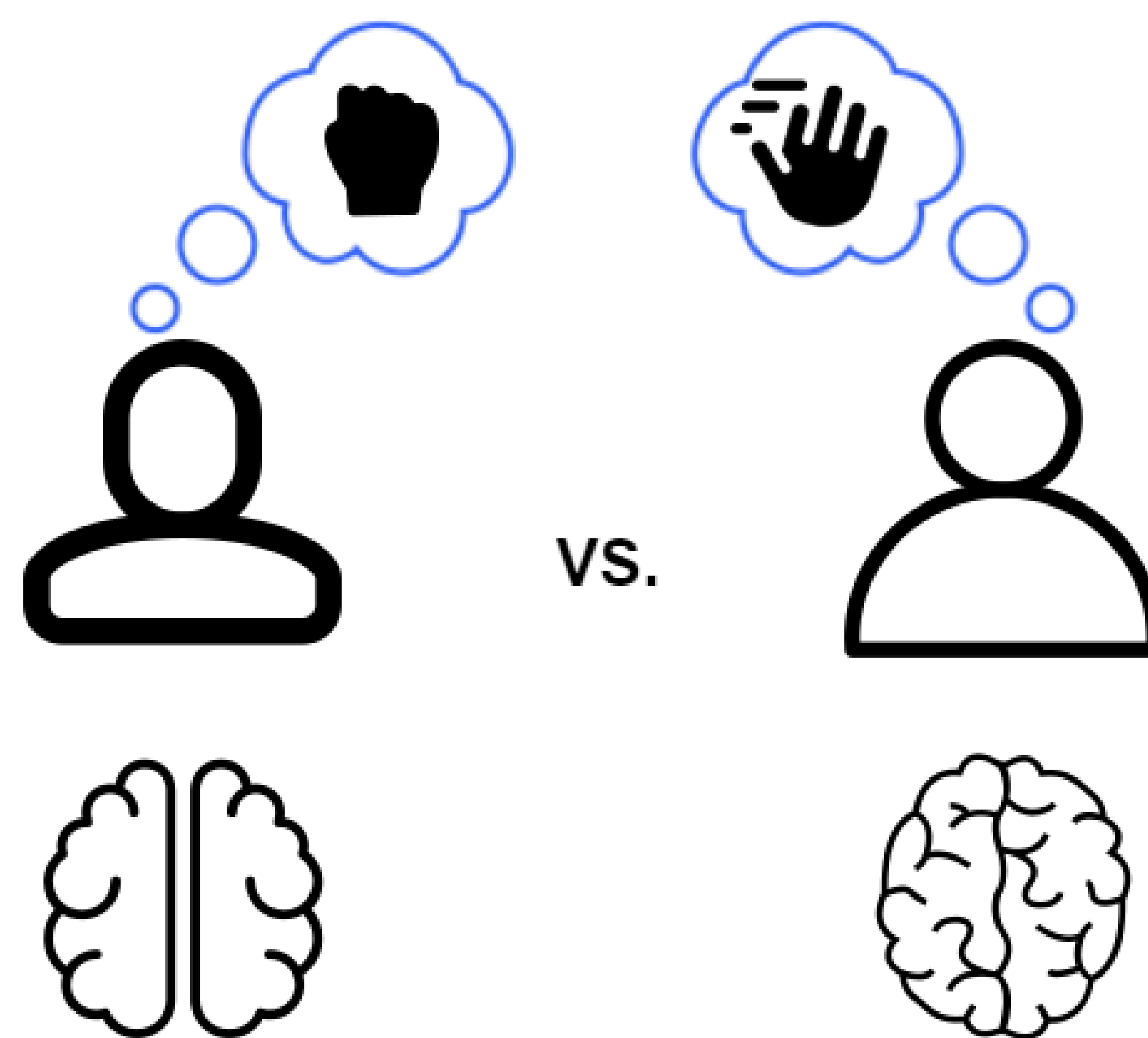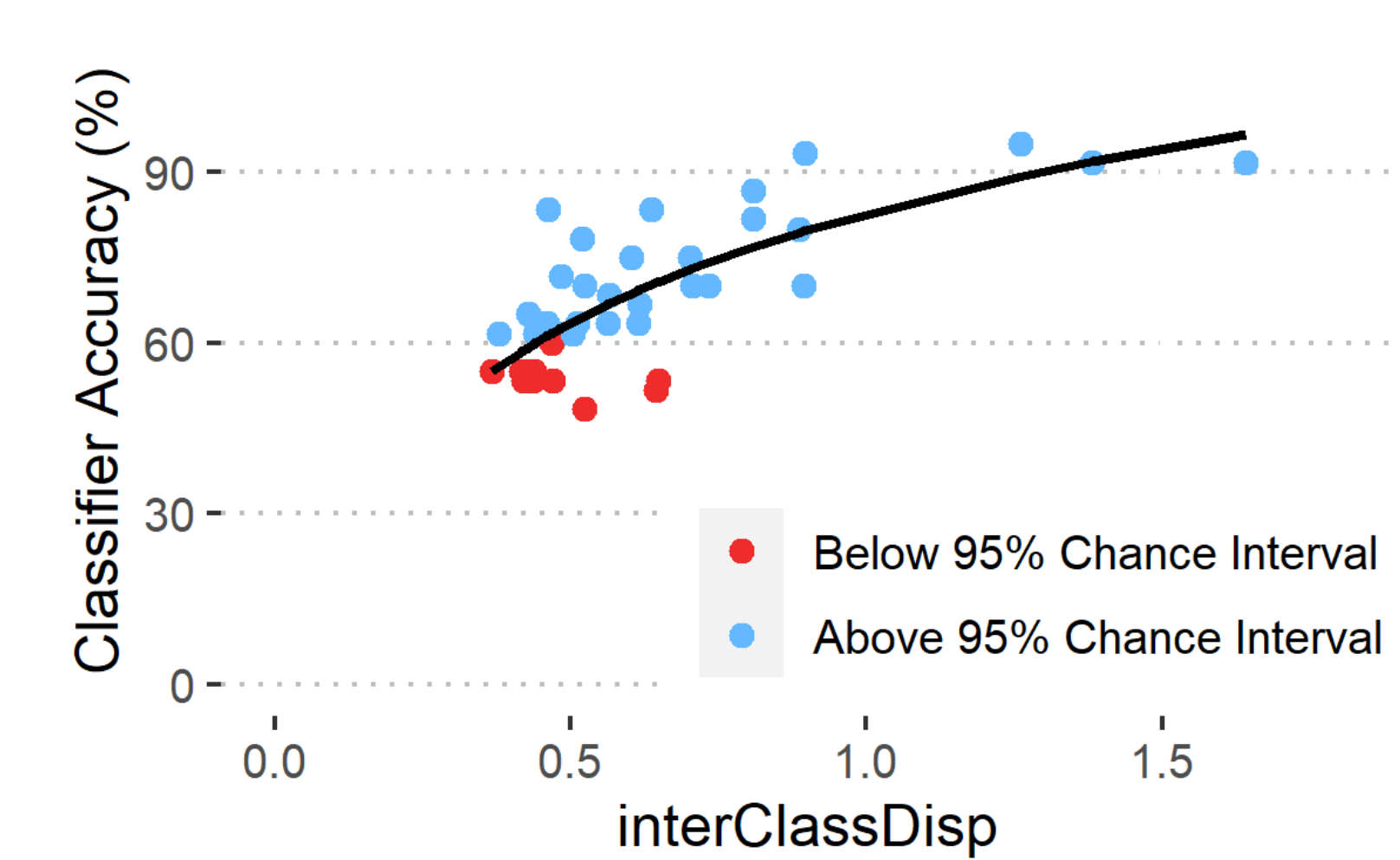

Every BCI user is unique and most need to **learn** how to perform mental tasks to control BCIs

Improving BCI-skill assessment and training feedback

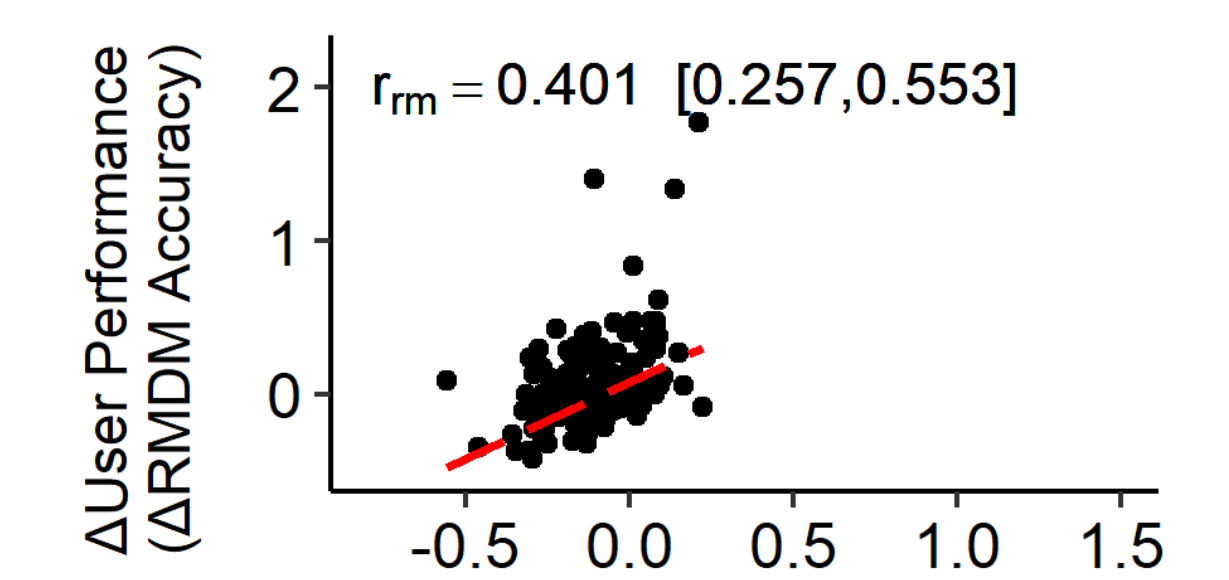Skill learning is **goal oriented**, which requires:

1. An **accurate assessment** of task performance and how performance changes during training
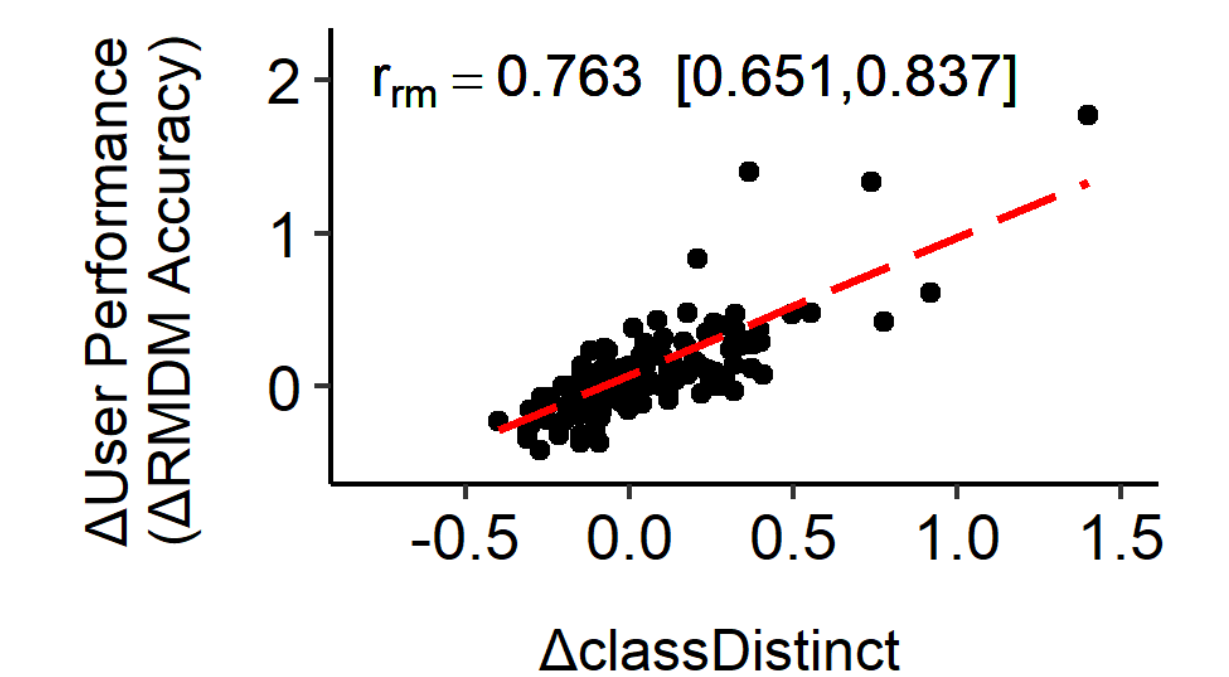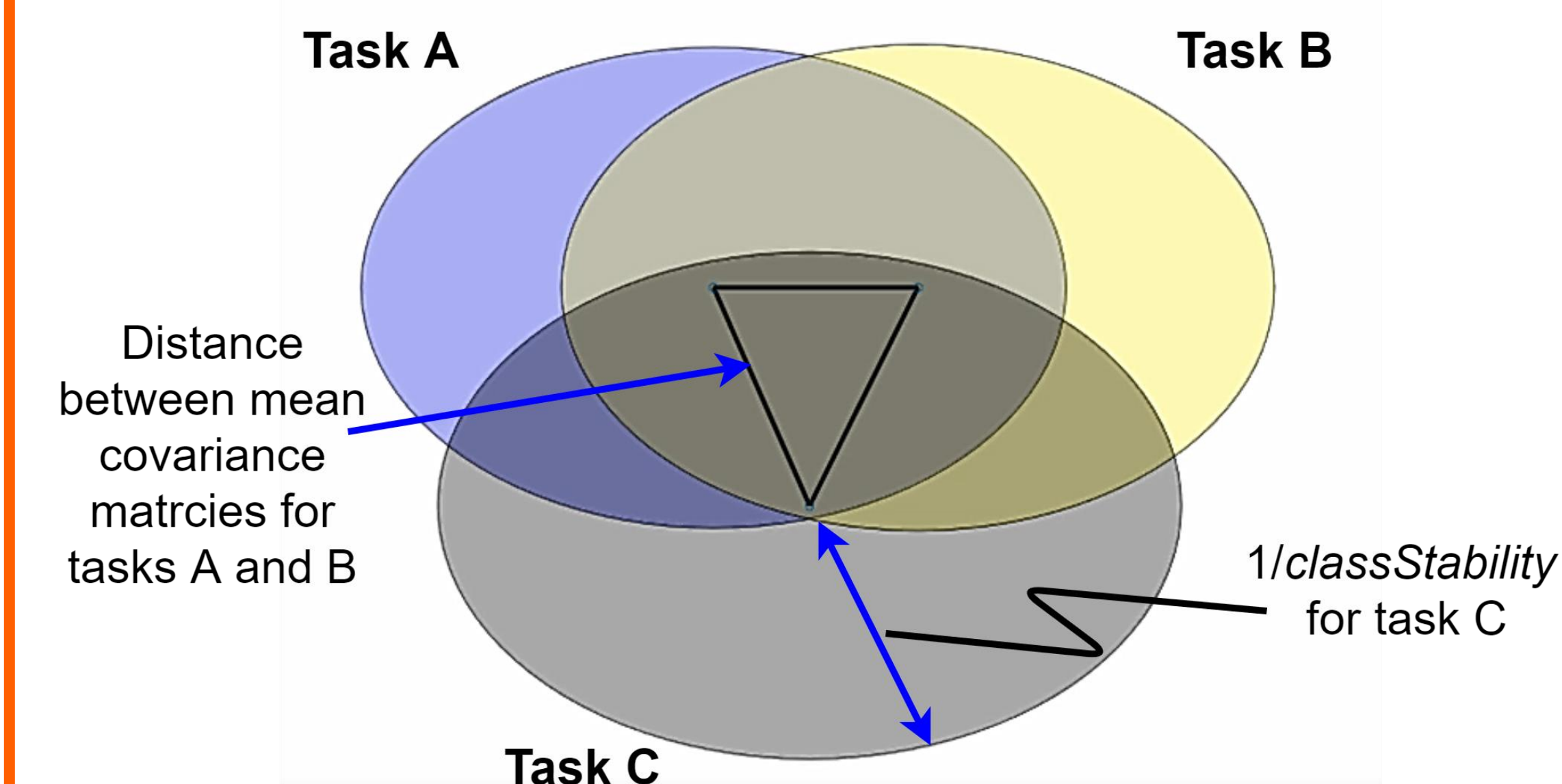

Newly proposed metrics based on difference between tasks and individual task consistency predictive of BCI performance (left)[5] and correlated with changes in BCI performance (right)[6]

2. **Feedback that clearly communicates** current, and changes in, performance level

Feedback interface illustrating inter-task differences (distance between circles) and task consistency (size of circle)[5]
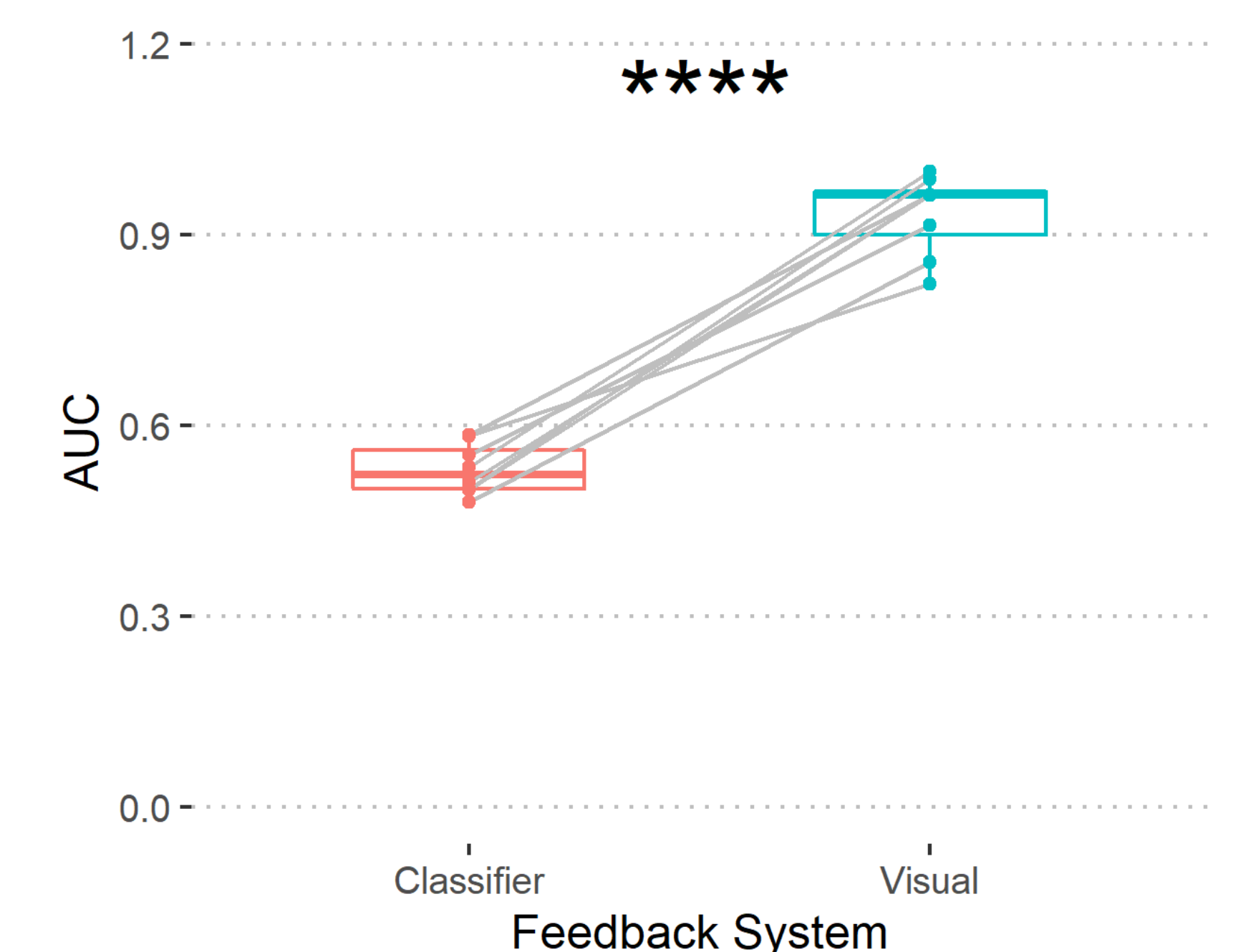
Users better able to correctly infer changes in performance using this feedback compared to standard BCI feedback[5]

Conclusions & Future work

BCI training can be improved using metrics and feedback that enables exploration and experimentation with different mental tasks

Future work: Training without prescribed tasks to increase user freedom

[1]Lotte F, Larrue F, Mühl C. Flaws in current human training protocols for spontaneous brain-computer interfaces: lessons learned from instructional design. Frontiers in human neuroscience. 2013 Sep 17;7:568.
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[3]Jeunet C, Jahanpour E, Lotte F. Why standard brain-computer interface (BCI) training protocols should be changed: an experimental study. Journal of neural engineering. 2016 May 11;13(3):036024.
[4]Roc A, Pillette L, Mladenovic J, Benaroch C, N'Kaoua B, Jeunet C, Lotte F. A review of user training methods in brain computer interfaces based on mental tasks. Journal of Neural Engineering. 2020 Nov 12.
[5]Ivanov N, Chau T. Development of a feedback interface to guide skill acquisition for SMR-BCI control. Submitted to Journal of Neural Engineering. 2021 Sept.
[6]Ivanov N, Chau T. Adapting Riemannian geometry-based user-performance metrics for sensorimotor rhythm brain-computer interface-user training. Submitted to IEEE Transactions on Neural Systems and Rehabilitation Engineering. 2021 Sept.