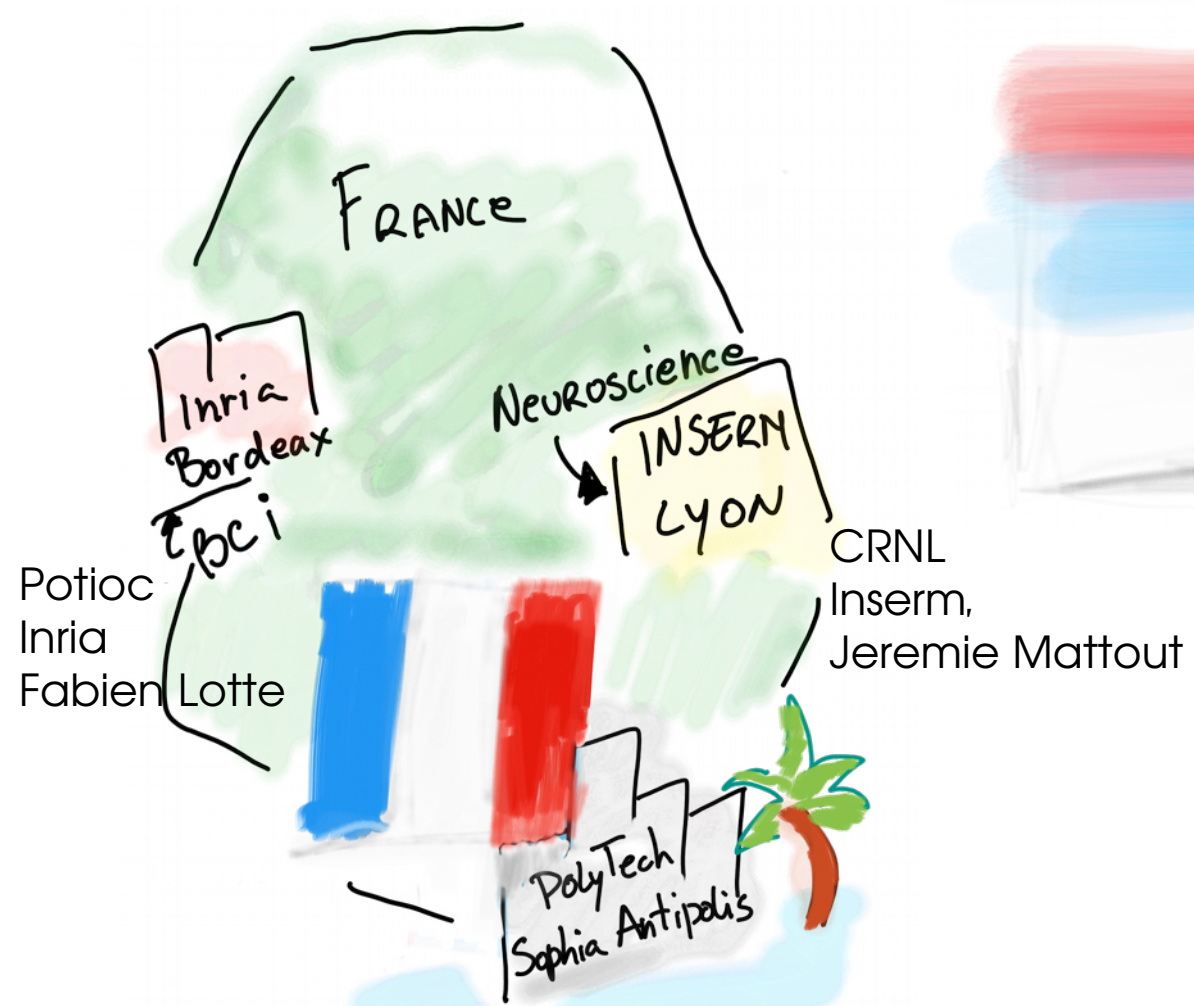
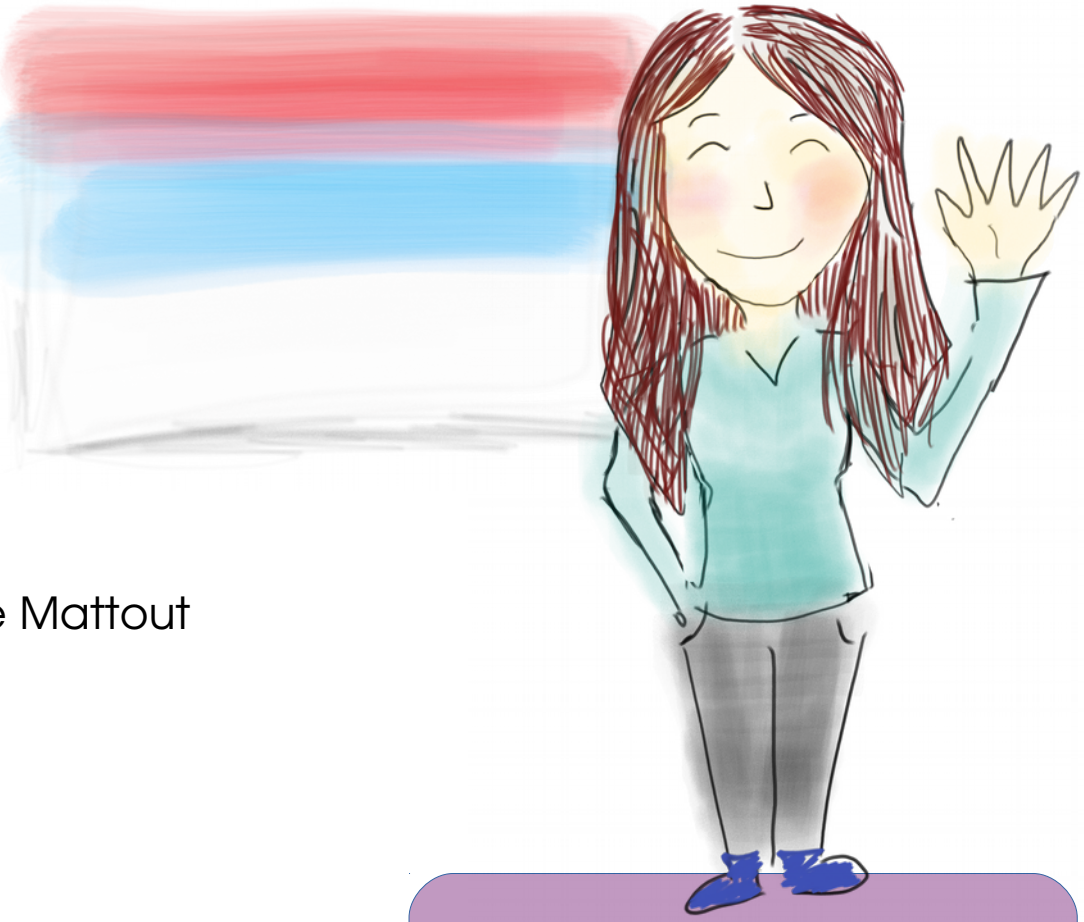
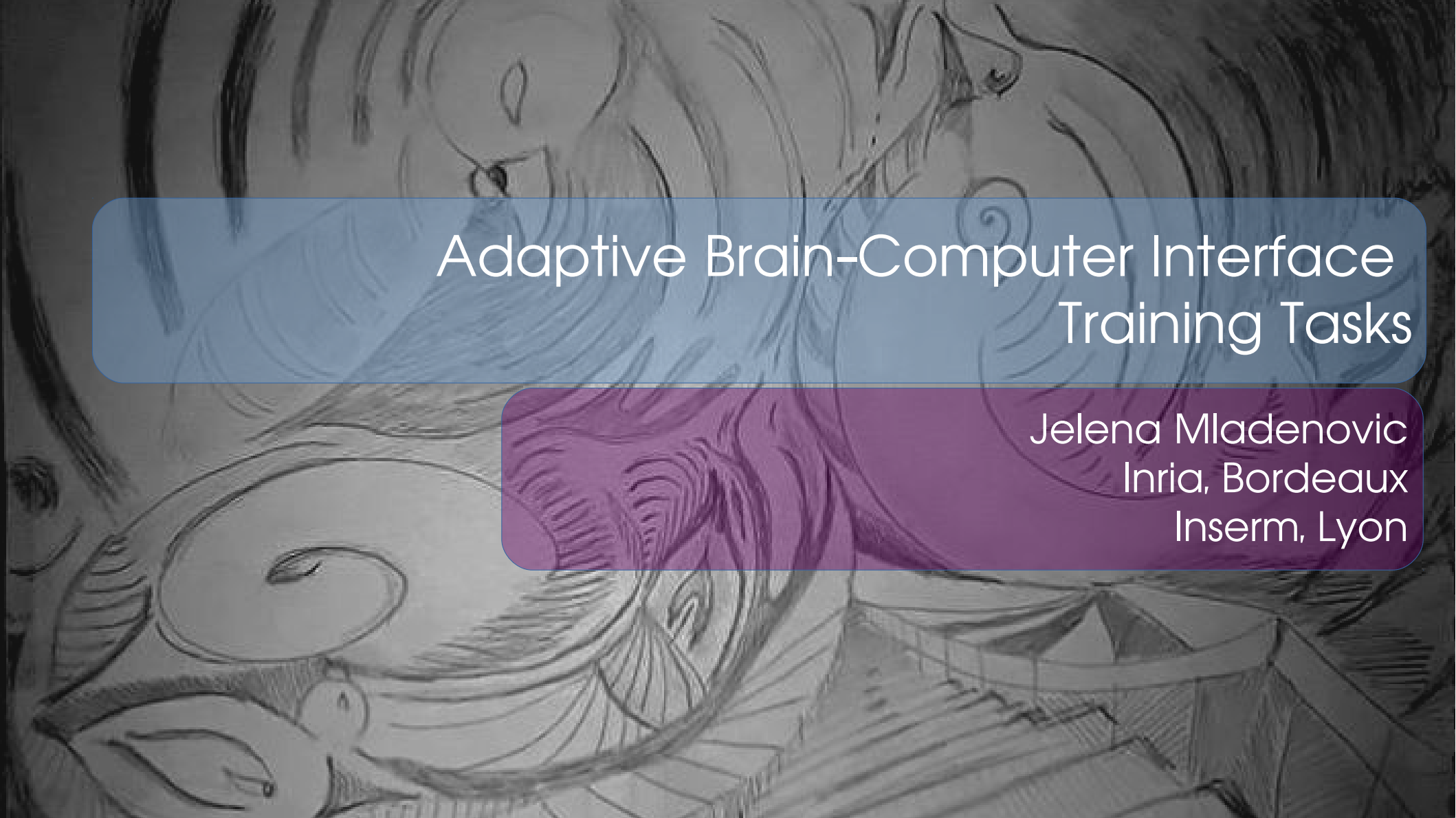




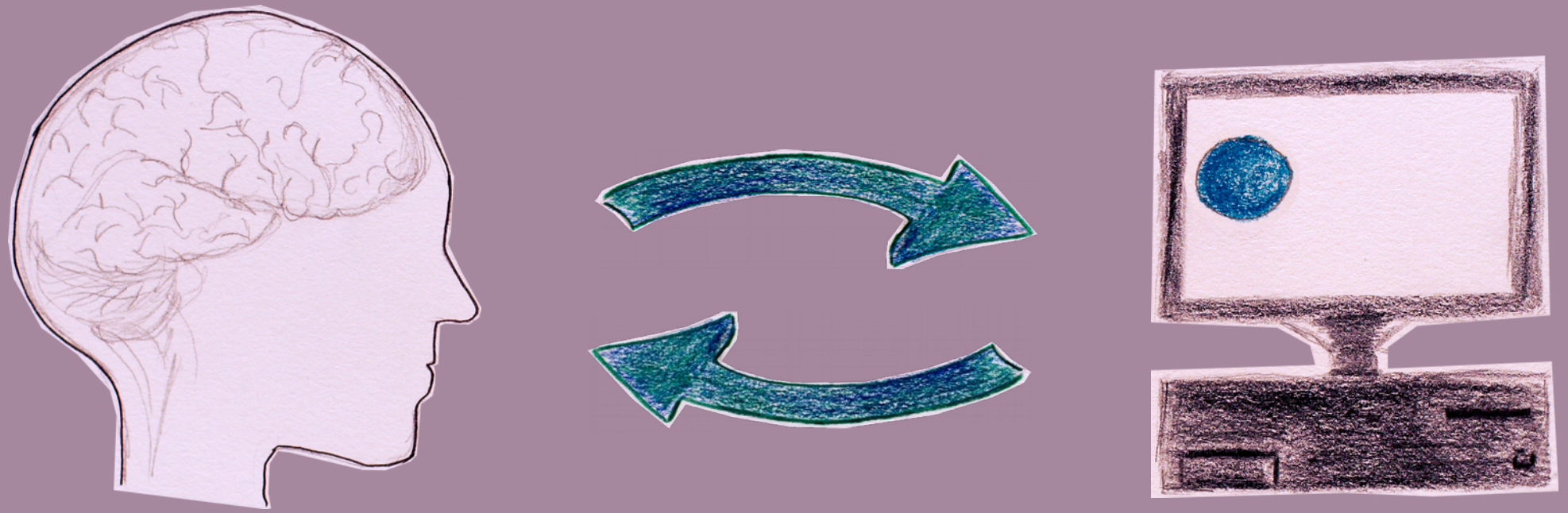
Jelena Mladenovic
PhD, Inria, Inserm



Adaptive Brain-Computer Interface Training Tasks

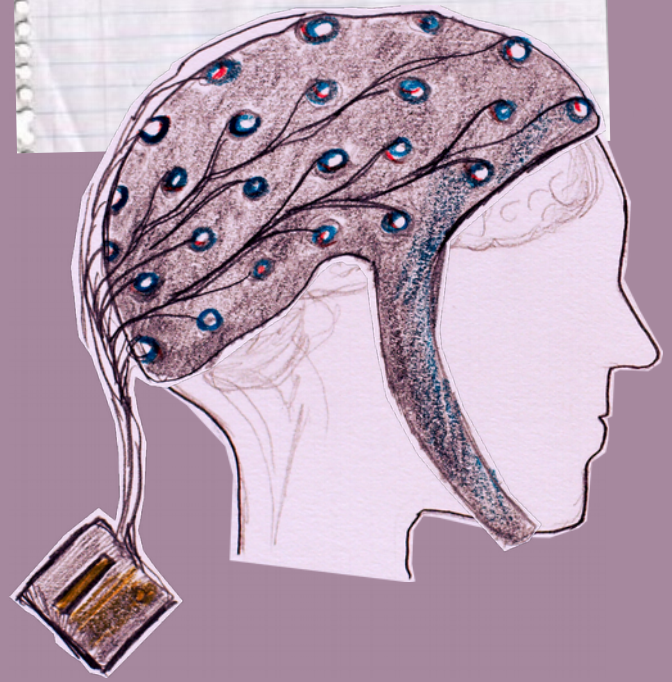
Jelena Mladenovic
Inria, Bordeaux
Inserm, Lyon

What is a **B**rain **C**omputer **I**nterface (BCI)?



Brain Computer Interface:

1. Measure brain activity



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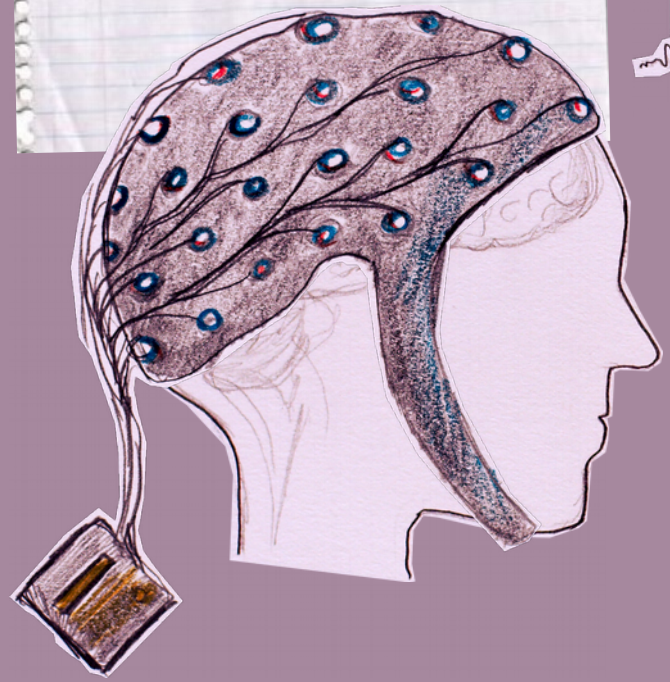

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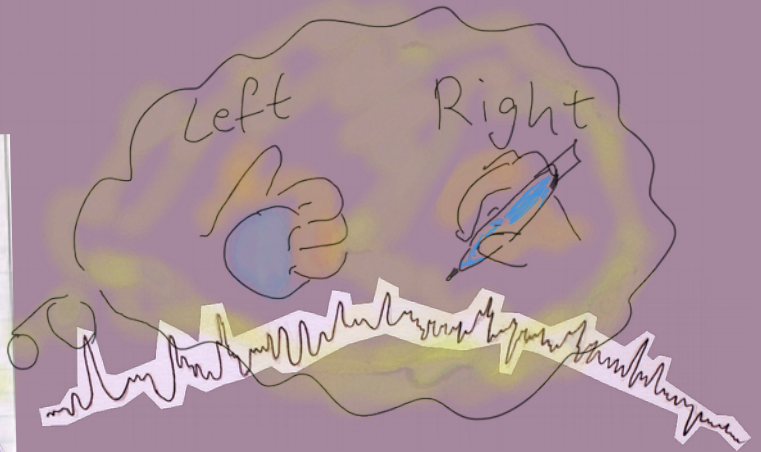

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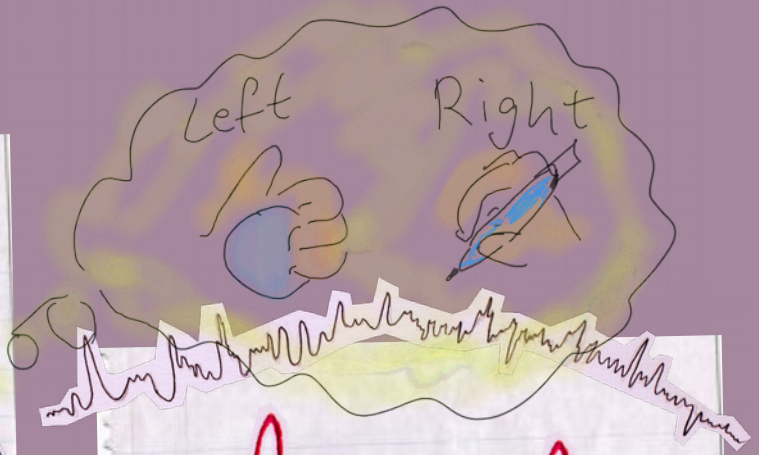
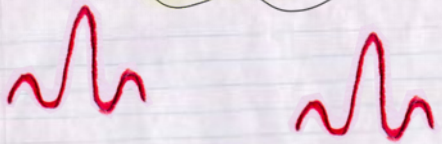
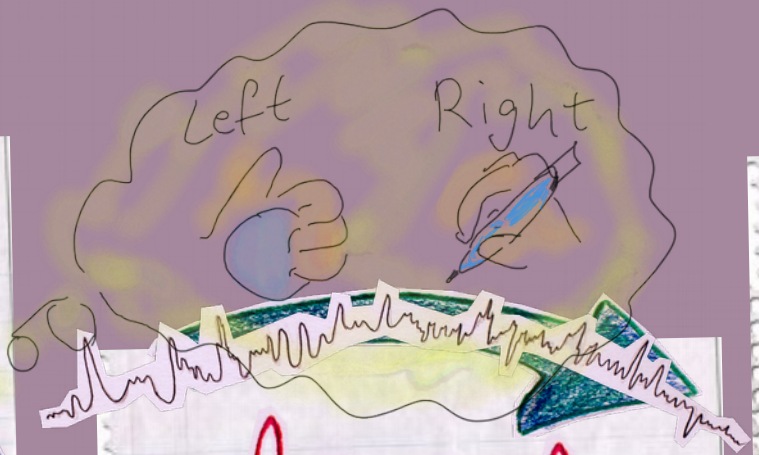




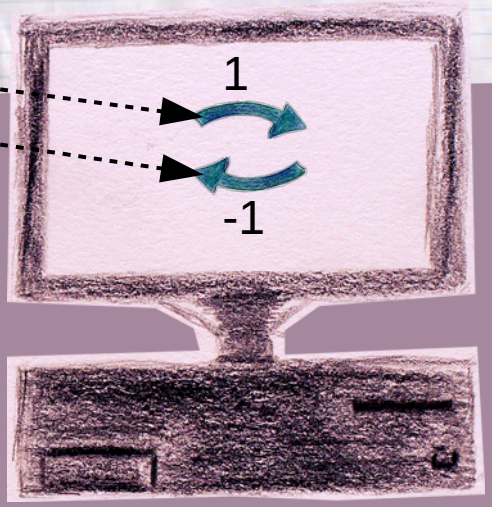
2. Filter, process data

1. Measure brain activity

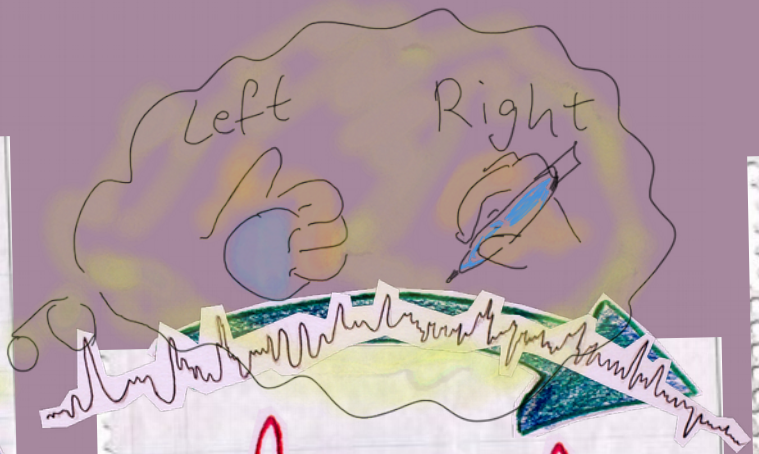


2. Filter, process data

3. Translate data into commands



1. Measure brain activity



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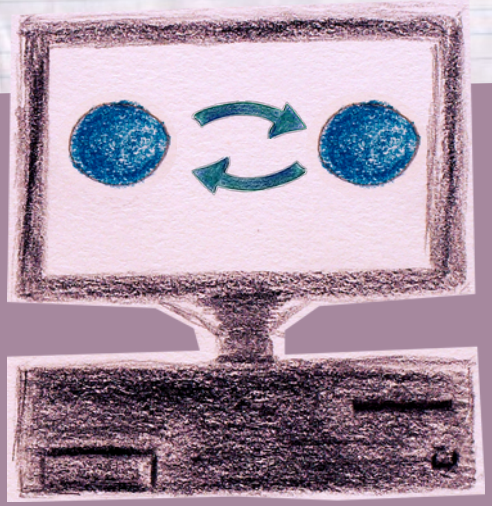
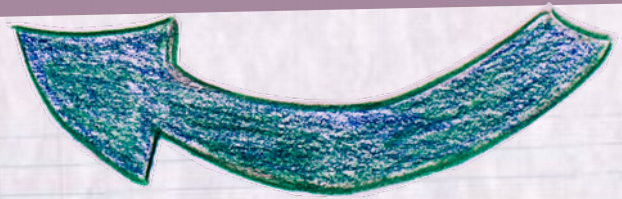


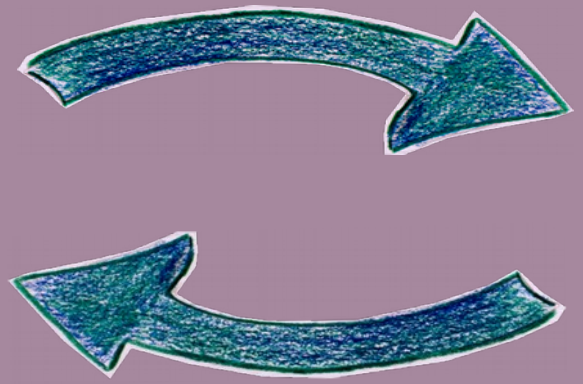


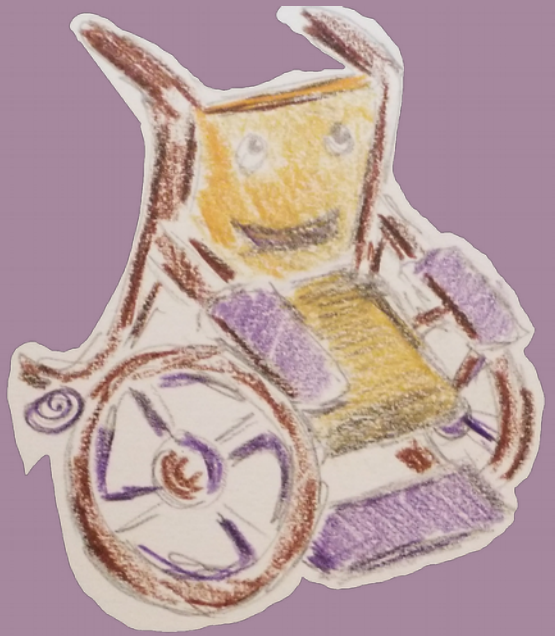
4. Provide feedback

BCI Applications

BCI is a system which enables a person to manipulate a machine

with only brain activity

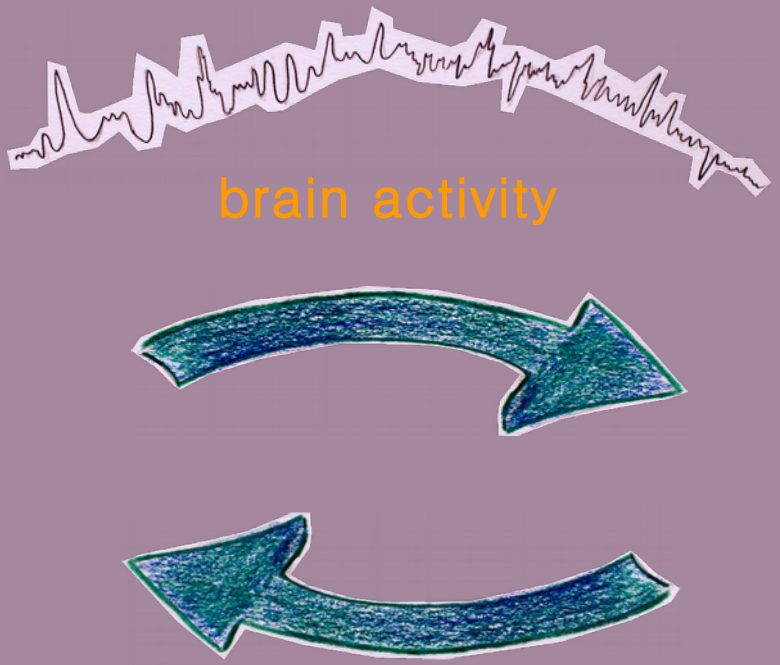


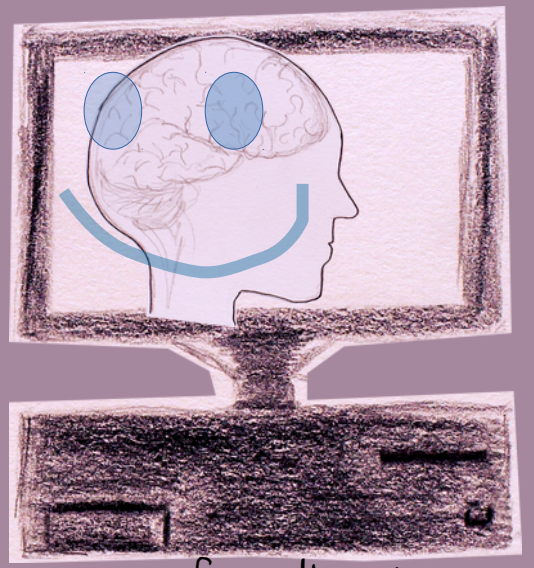


BCI Applications

passive

BCI is a system which enables a person to monitor and regulate



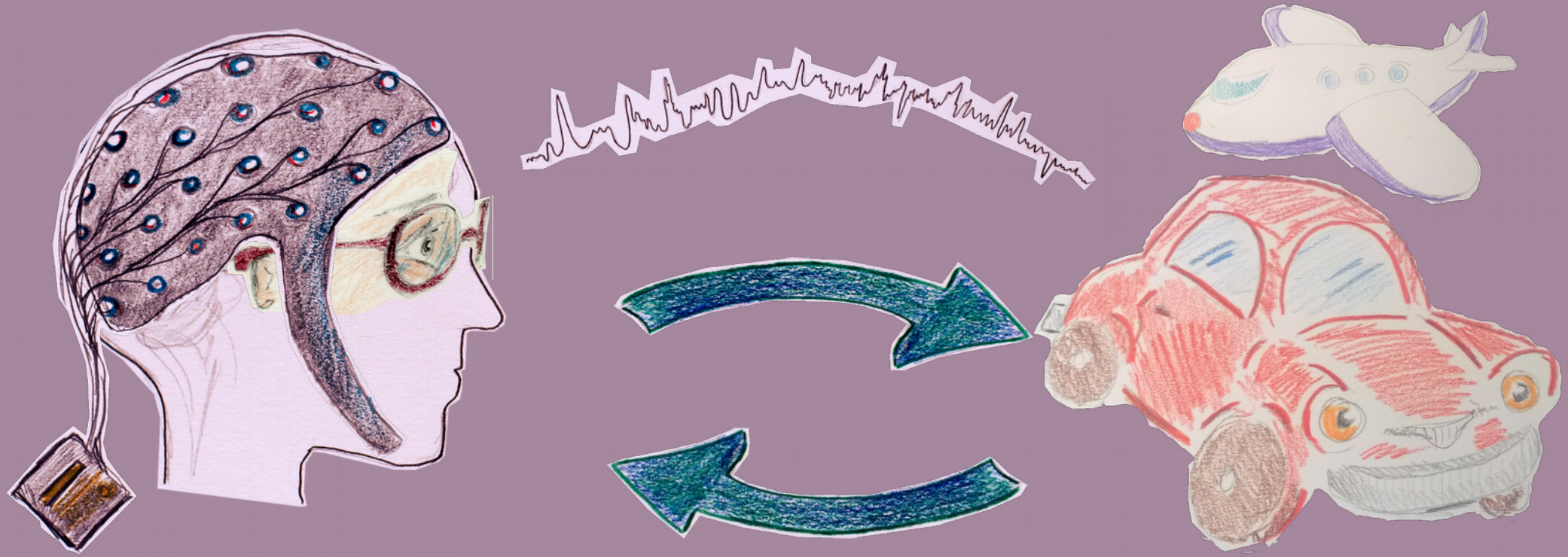


neuofeedback

BCI Applications

passive

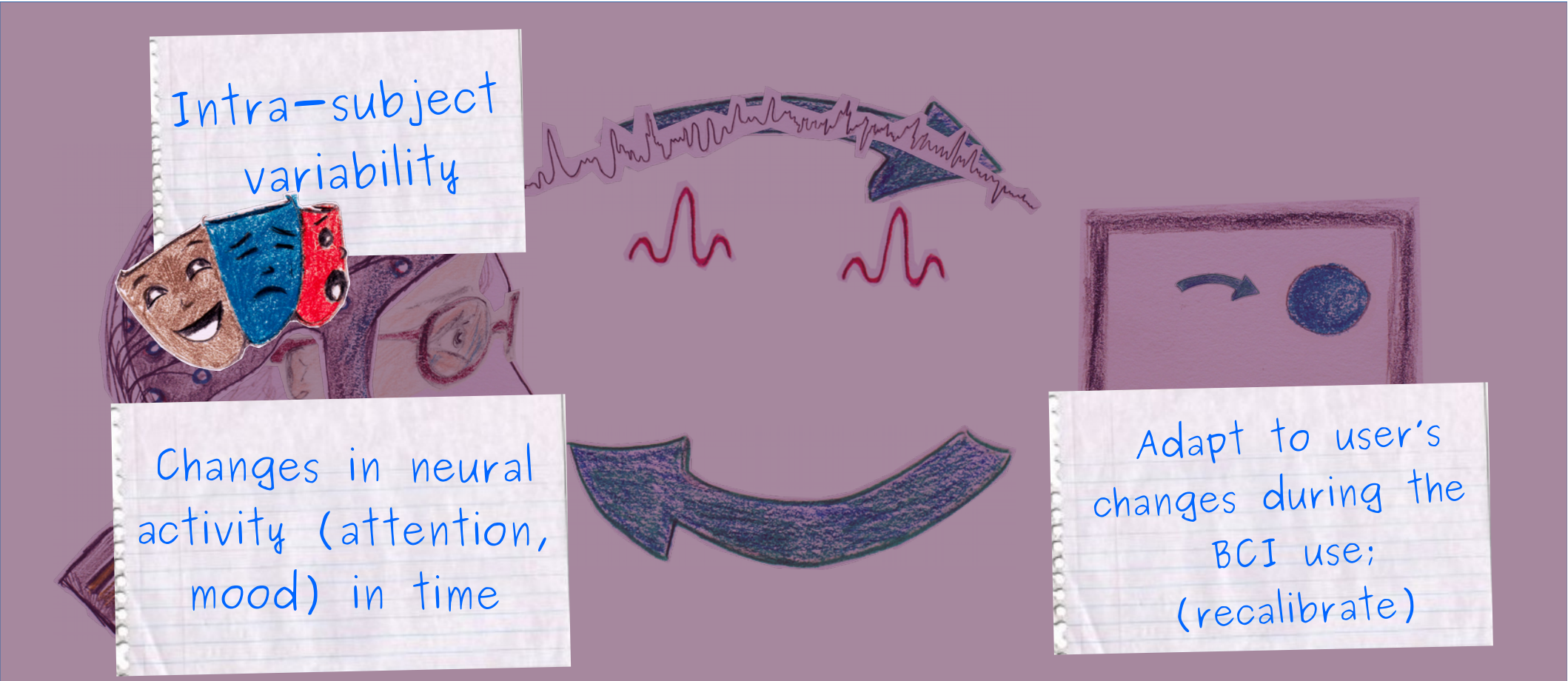
BCI uses brain activity to adapt a device for higher comfort or safety



Not reliable outside labs, low performance:

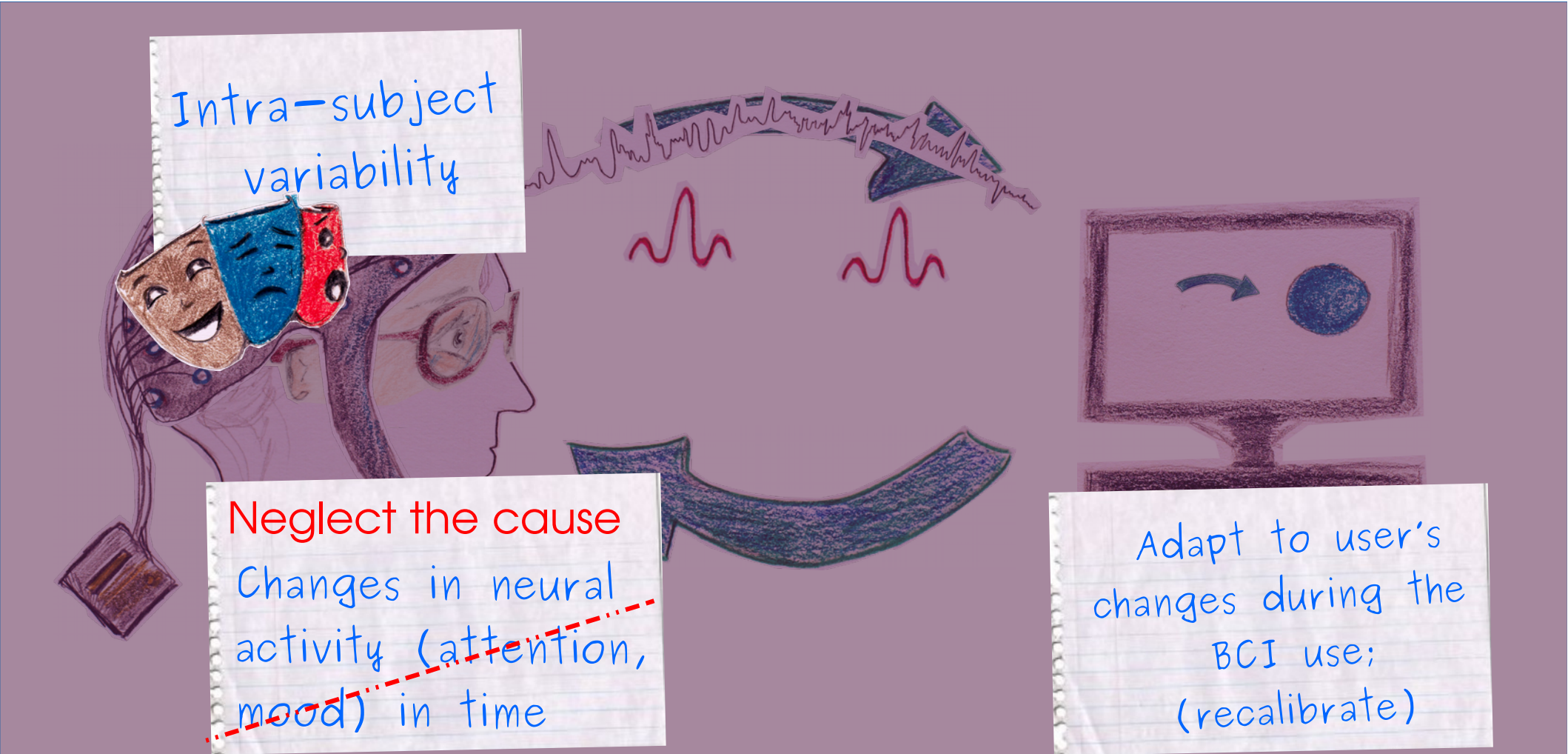
Solution – User Centered:

Solution, Adaptive Machines:

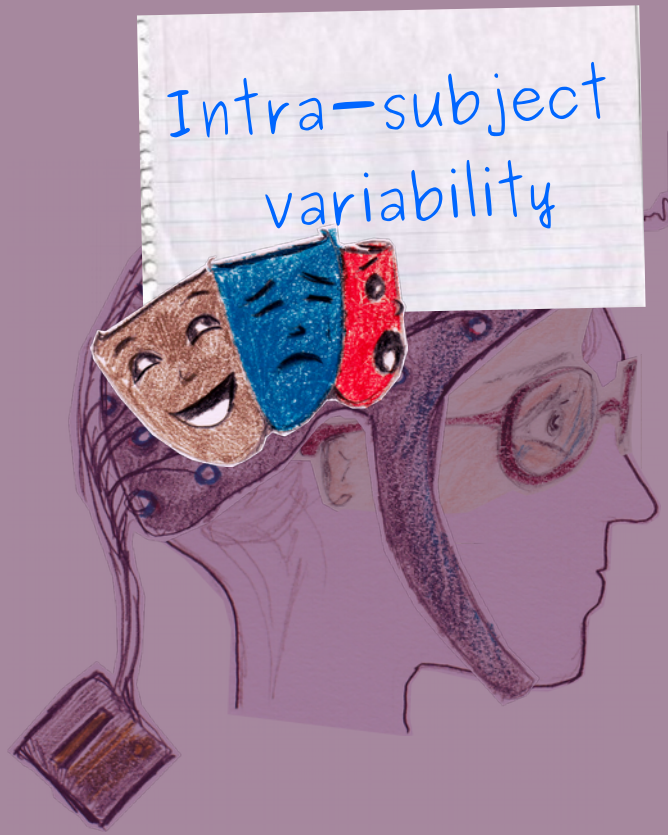


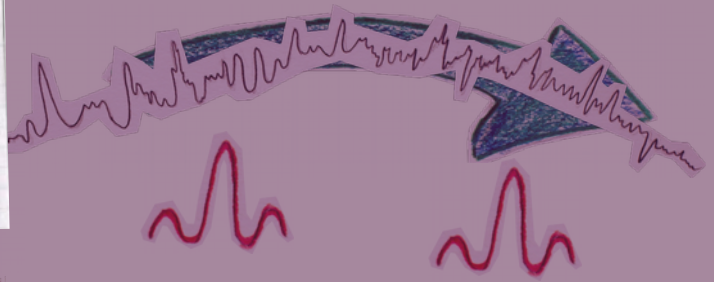
Faller, Josef, et al. "A co-adaptive brain-computer interface for end users with severe motor impairment." PloS one 9.7 (2014): e101168.

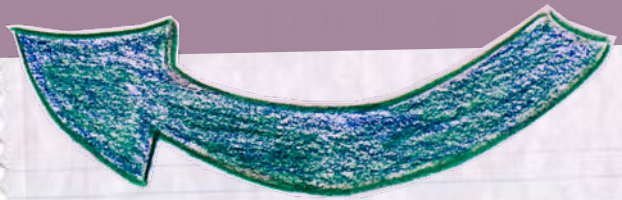
Gives higher performance, but…



New Solution, Engaging Task – adaptive:

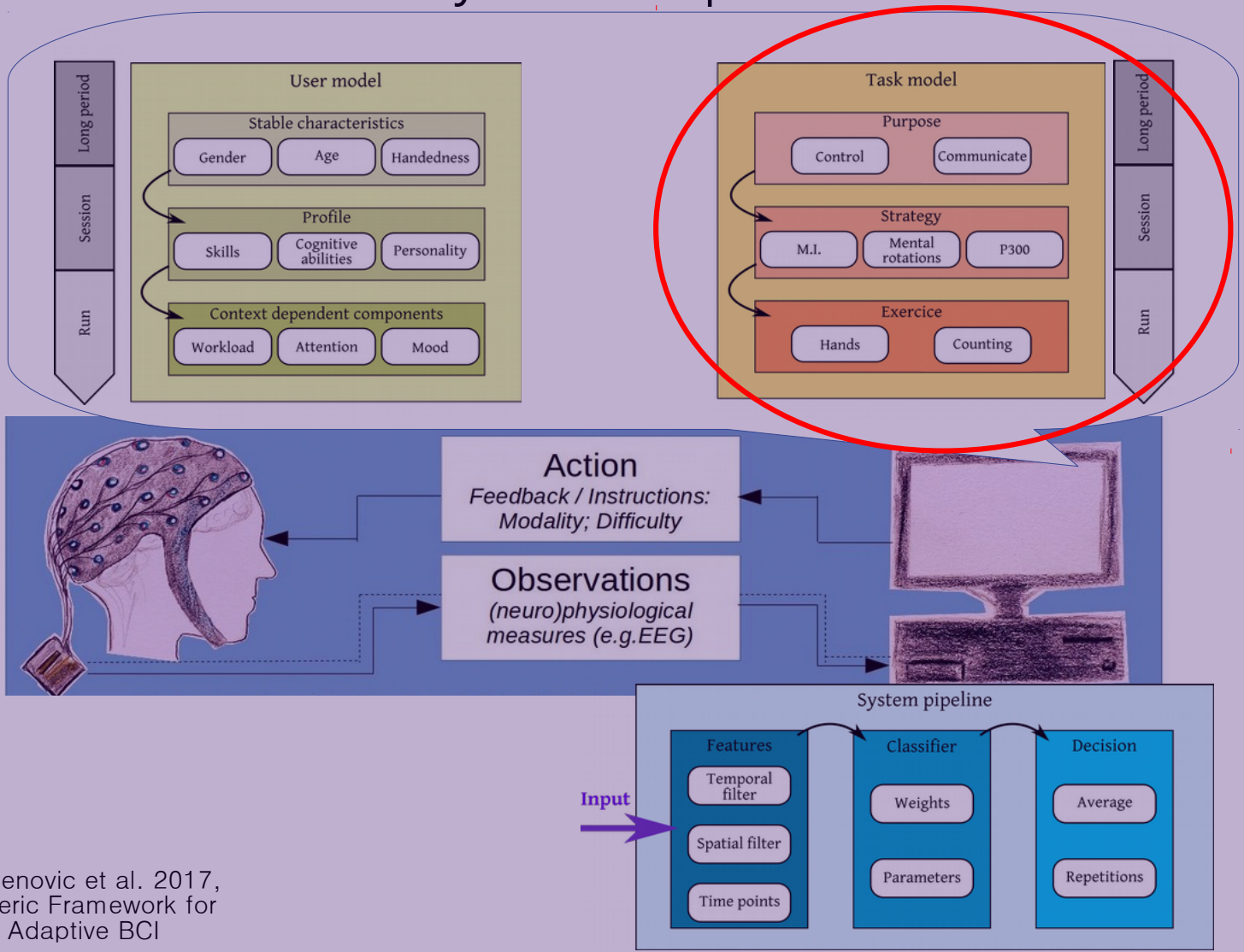






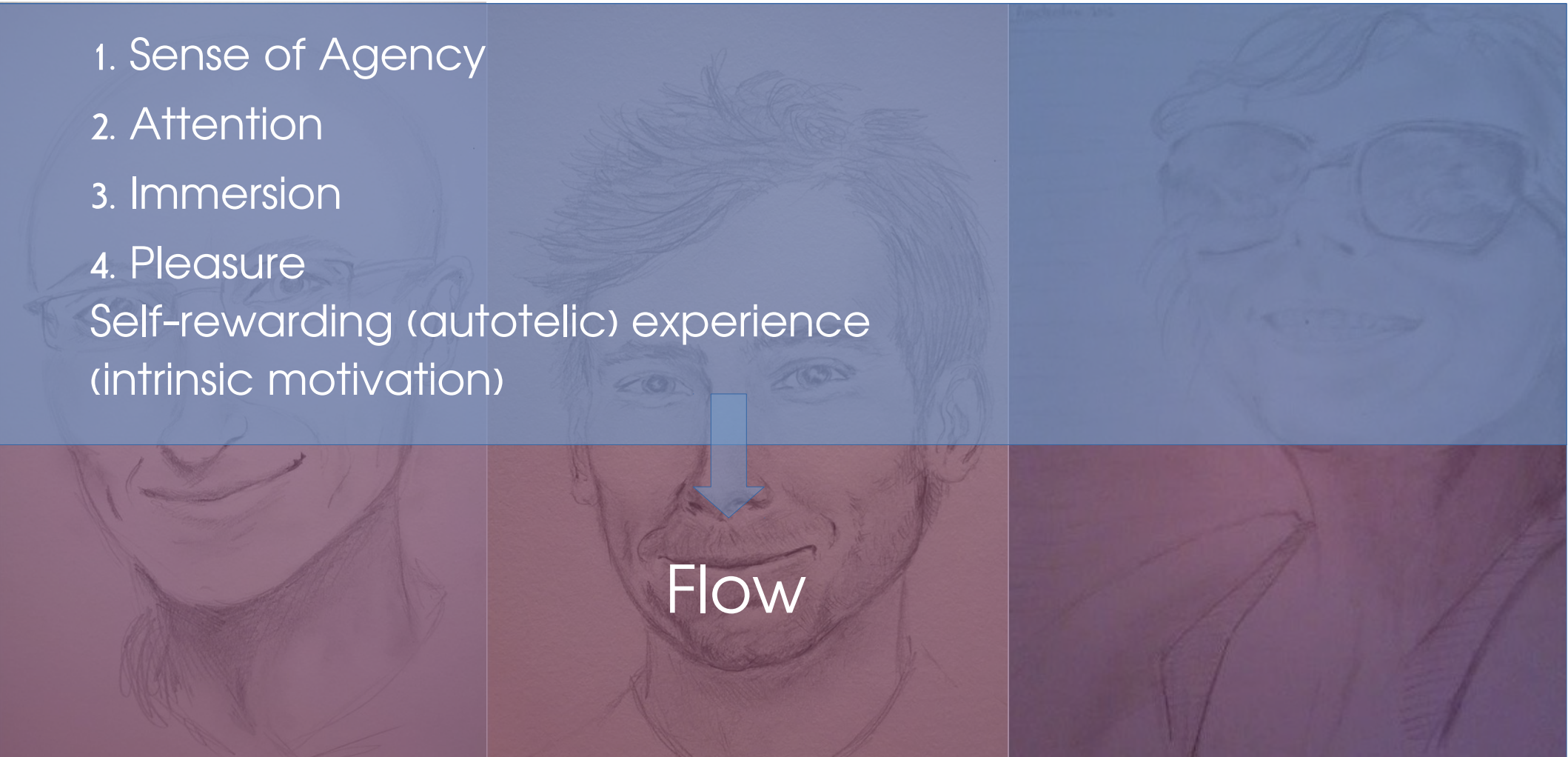
Influence to
reach desired
behavior

Taxonomy of Adaptive BCIs



Mladenovic et al. 2017,
Generic Framework for
Adaptive BCI

Desired user states:



1. Sense of Agency
2. Attention
3. Immersion
4. Pleasure

Self-rewarding (autotelic) experience
(intrinsic motivation)

Flow

FLOW

"...It is when we act freely, for the sake of the action itself rather than for ulterior motives, that we learn to become more than what we were."

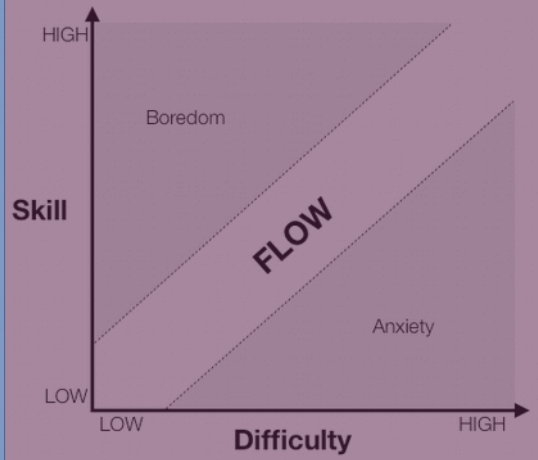
"...the self expands through acts of self forgetfulness."

"Enjoyment appears at the boundary between boredom and anxiety, when the challenges are just balanced with the person's capacity to act."

– Mihaly Csikszentmihalyi, (1975)
Flow: The Psychology of Optimal Experience

Immerssive, playful content

Matching task difficulty with skill

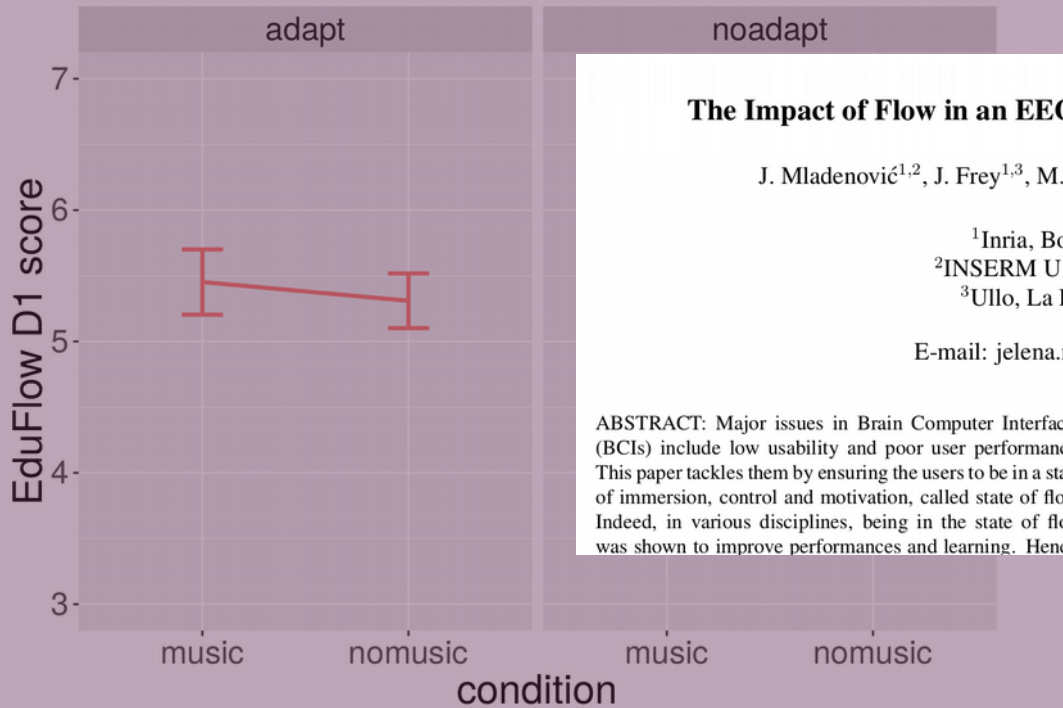


Paper

1. Participants felt more in flow in the adapt condition
2. Correlation between offline performance and flow state

*Flow assessed with EduFlow Questionnaire (Heutte 2016)

*Offline performance – k-fold cross-validation



The Impact of Flow in an EEG-based Brain Computer Interface

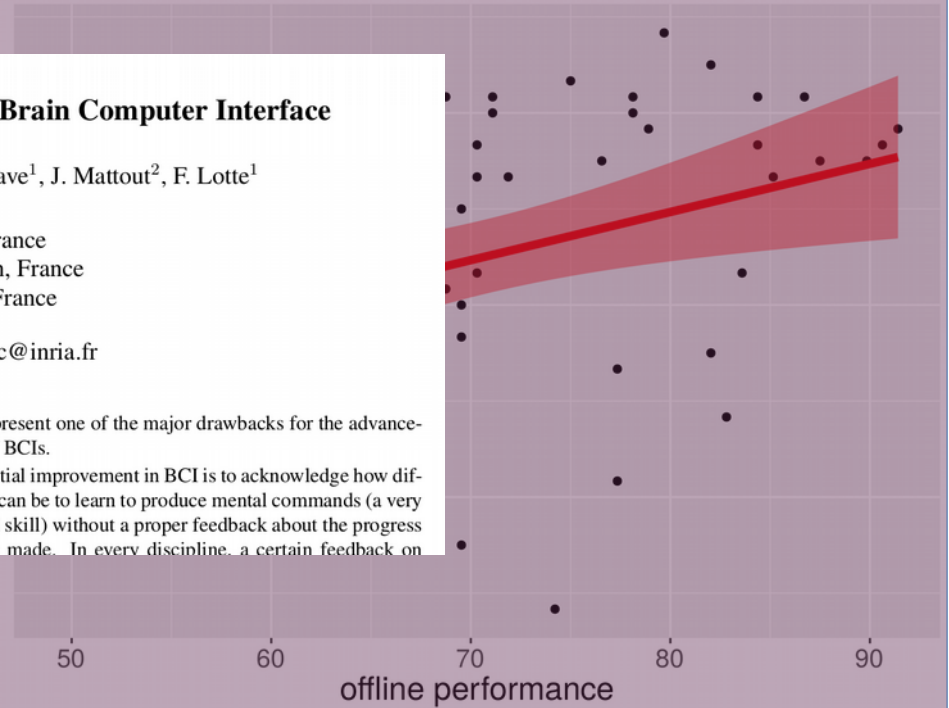
J. Mladenović[1,2], J. Frey[1,3], M. Bonnet-Save[1], J. Mattout[2], F. Lotte[1]

[1]Inria, Bordeaux, France
[2]INSERM U1028, Lyon, France
[3]Ullo, La Rochelle, France

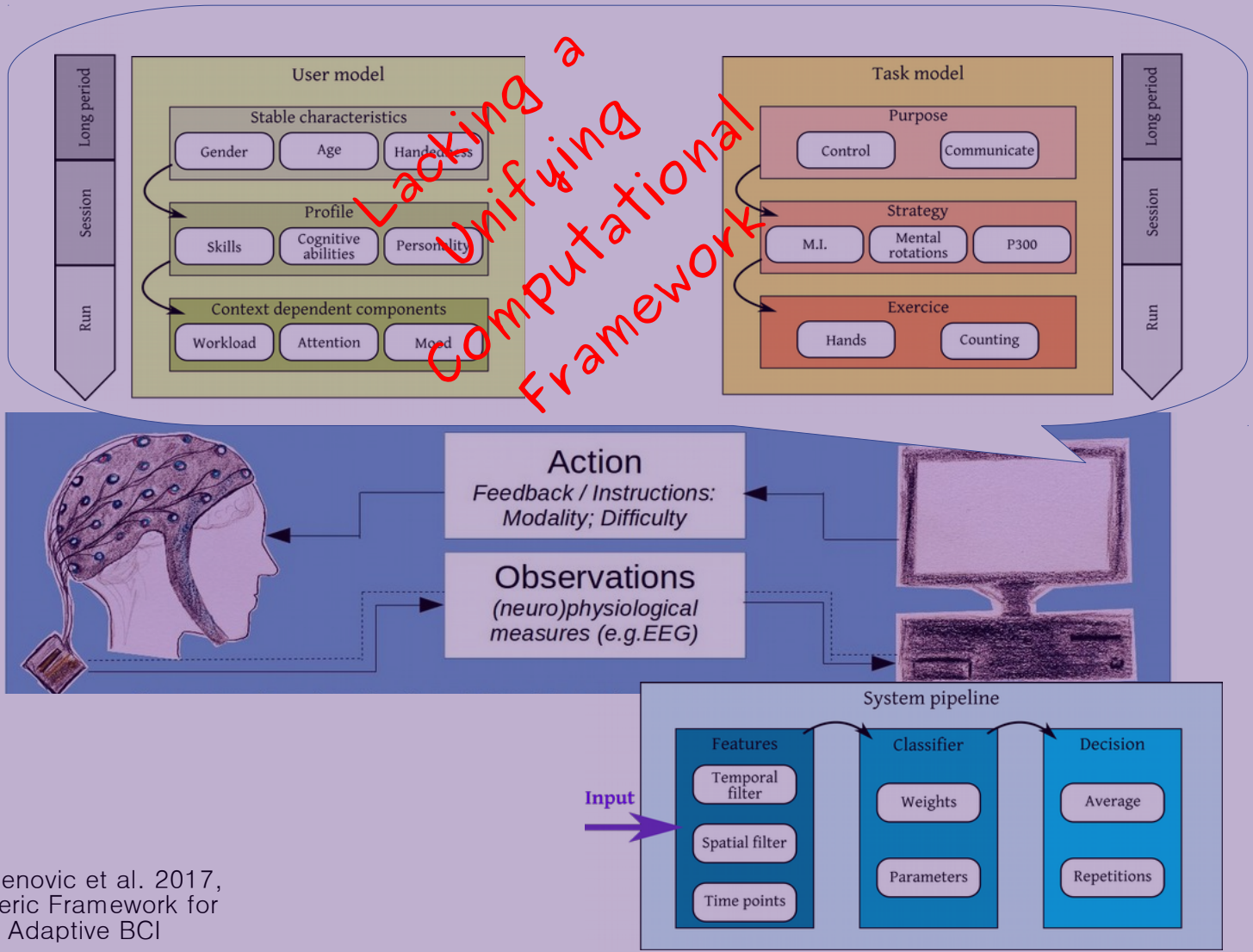
E-mail: jelena.mladenovic@inria.fr

ABSTRACT: Major issues in Brain Computer Interfaces (BCIs) include low usability and poor user performance. This paper tackles them by ensuring the users to be in a state of immersion, control and motivation, called state of flow. Indeed, in various disciplines, being in the state of flow was shown to improve performances and learning. Hence, may represent one of the major drawbacks for the advancement of BCIs.

A potential improvement in BCI is to acknowledge how difficult it can be to learn to produce mental commands (a very atypical skill) without a proper feedback about the progress one has made. In every discipline, a certain feedback on



Taxonomy of Adaptive BCIs



Mladenovic et al. 2017,
Generic Framework for
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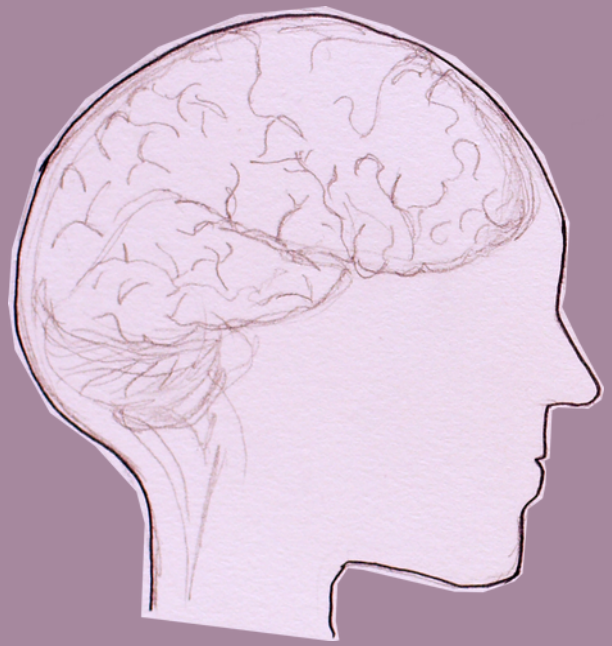
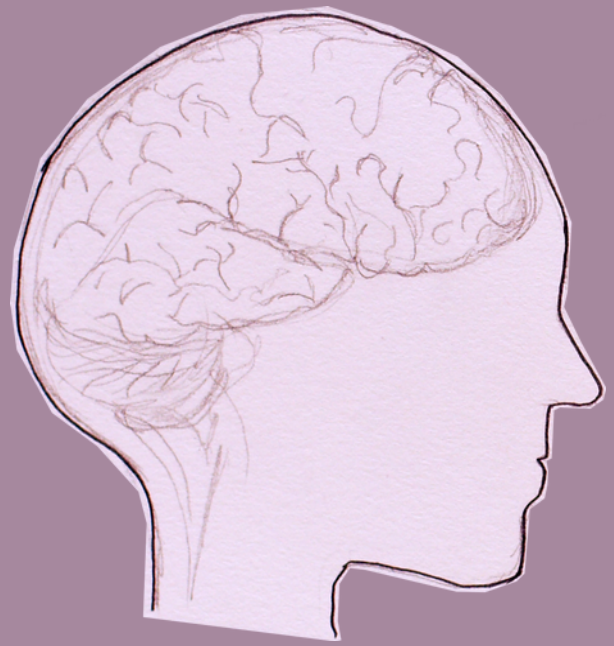
Neuroscience – Bayesian brain



Rao, Rajesh PN, and Dana H. Ballard. "Predictive coding in the visual cortex: a functional interpretation of some extra-classical receptive-field effects." Nature neuroscience 2.1 (1999):

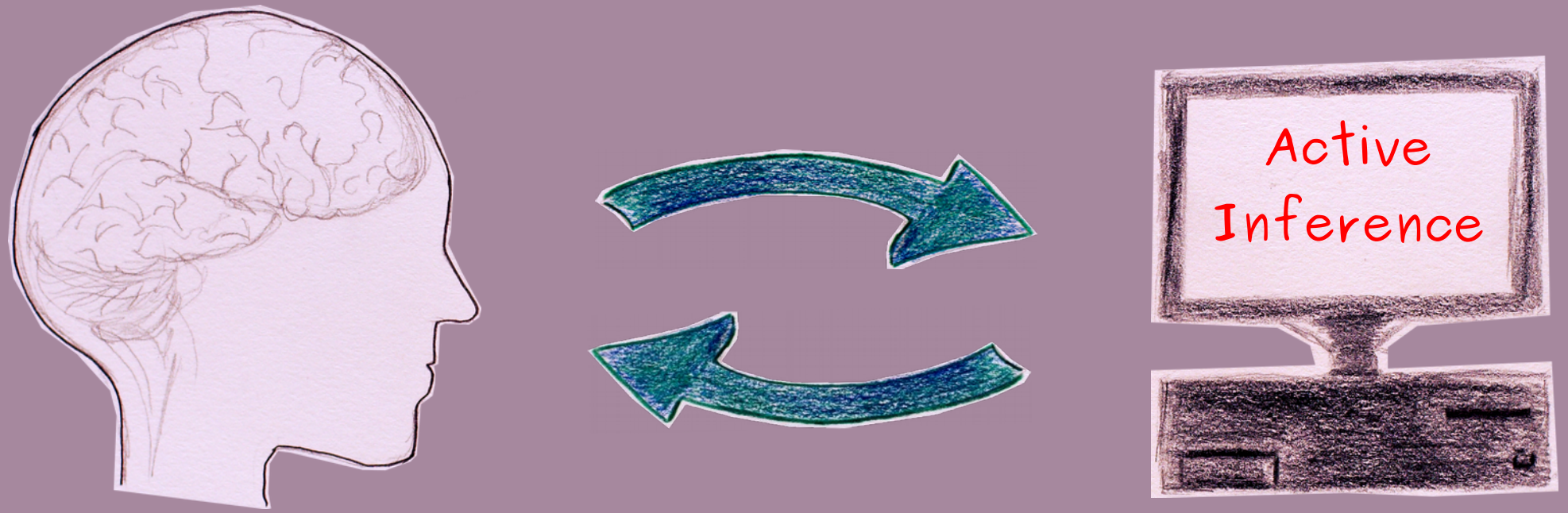
Neuroscience – Bayesian brain

Active Inference



Friston, Karl, et al. "Active inference and learning."
Neuroscience & Biobehavioral Reviews 68 (2016): 862-879.

Endowing the Machine with Active Inference



Mladenović, Jelena, et al. "Endowing the Machine with Active Inference: A Generic Framework to Implement Adaptive BCI." NeuroAdaptive Technology Conference'17. 2017.

Thank You

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jelena.mladenovic@inria.fr