WASP | WALLENBERG AI, AUTONOMOUS SYSTEMS AND SOFTWARE PROGRAM

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Realtime Individualization of Brain Computer Interfaces

MARIA SANDSTEN, CENTRE FOR MATHEMATICAL SCIENCES, BO BERNHARDSSON, DEPARTMENT OF AUTOMATIC CONTROL, MIKAEL JOHANSSON, DEPARTMENT OF PSYCHOLOGY

High hopes for future BCI-applications

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THIS WEEK 10 October 2018

Three people had their brains wired together so they could play Tetris

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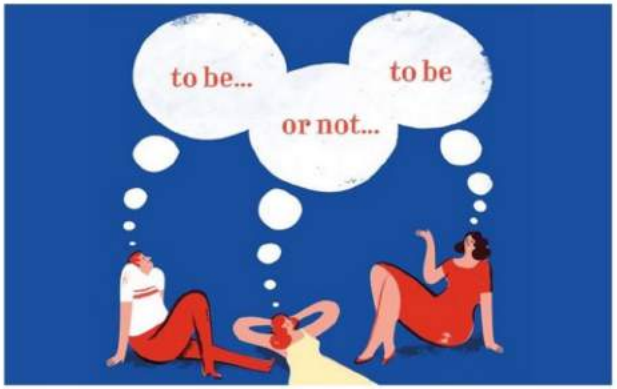
FEATURE 26 September 2018

Mind-reading devices can now access your thoughts and dreams using AI

We can now decode dreams and recreate images of faces people have seen, and everyone from Facebook to Elon Musk wants a piece of this mind reading reality



Ilse Aussteran

By Timothy Revell

I FEEL like a cross between an Olympic swimmer and a cyborg. On my head is a bathing-cap-like hat dotted with electrodes, and a cable dangles behind me.

David Ibanez and Marta Castellano, from the neuroscience company Starlab, look at me from across a table at their

17 Feb 2011 | 17:33 GMT

BrainDriver: A Mind Controlled Car

BrainDriver allows you to drive your car by thought

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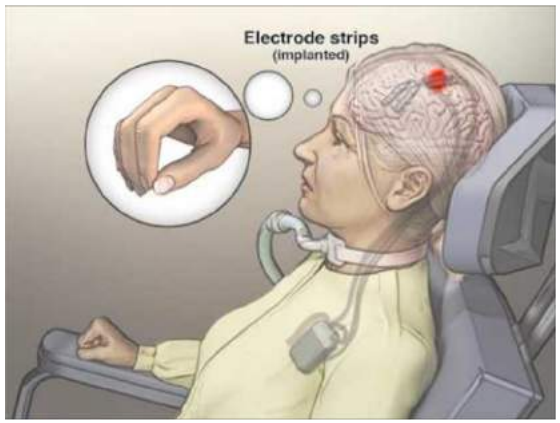
BCIs today



- Slow
- Long learn and calibration times
- Invasive sensors sometimes used
- Often captures ’perception’ instead of ’intention’

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Project Goal

Improved learning time, performance and robustness of EEG-based BCIs.

Possible applications in cognitive neuroscience, diagnostic medicine, forensic contexts, education, and beyond.

Research team

Maria Sandsten
Prof. Mathematical Statistics

Rachele Andersson
Postdoc Mathematical Statistics

Carolina Bergeling
Postdoc Automatic Control

Bo Bernhardsson
Prof. Automatic Control

Frida Heskebeck
PhD student Automatic Control

Mikael Johansson
Prof. Psychology

Ines Bramao
Ass. Lecturer Psychology

Andrey Nikolaev
Researcher Psychology

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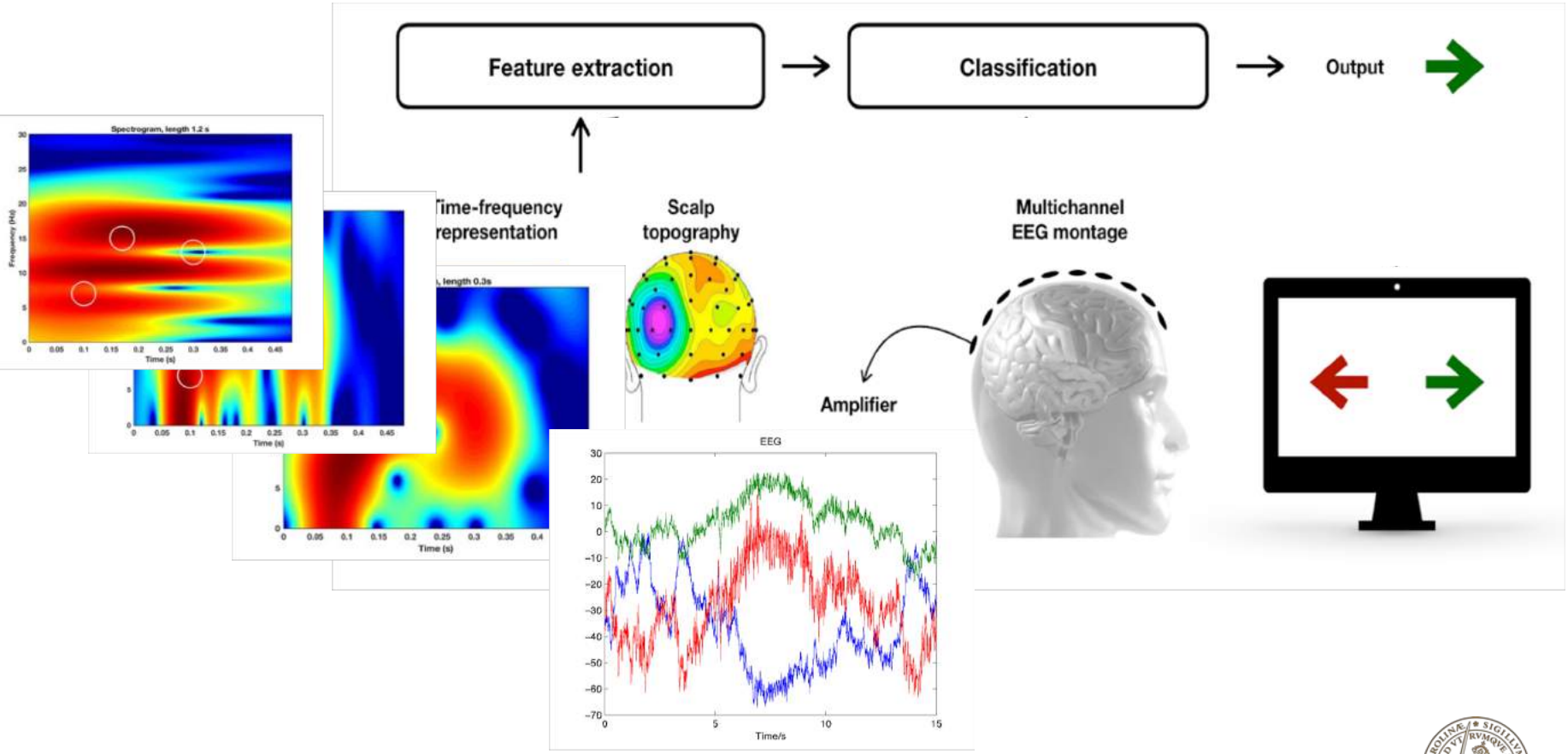
State-of-the-art
EEG-based Brain Computer Interfaces



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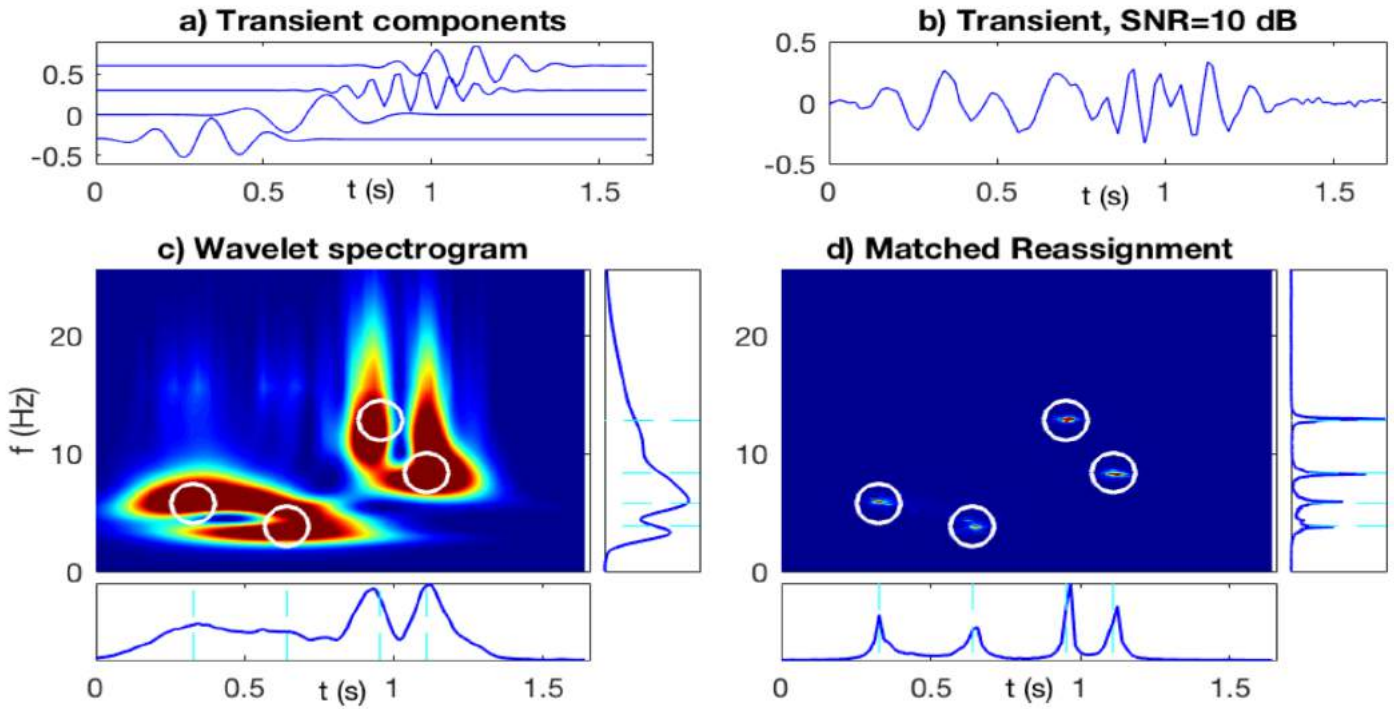
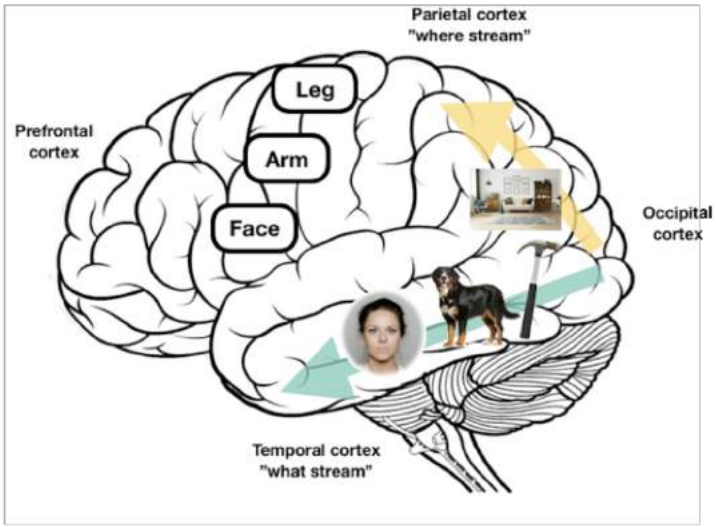
Example on improved resolution

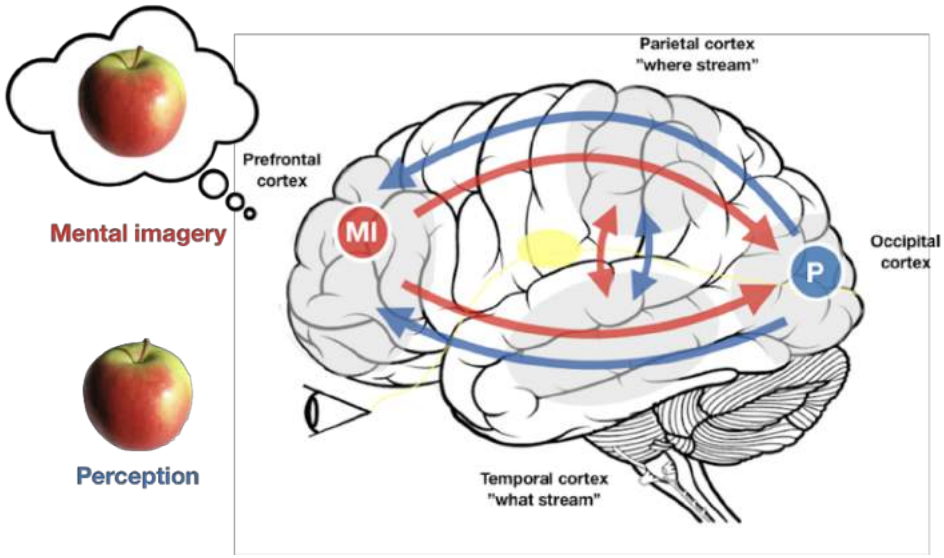


Spatial-Temporal Cognitive Models

A. Functional specialization



B. Reversed information flow perception and imagery



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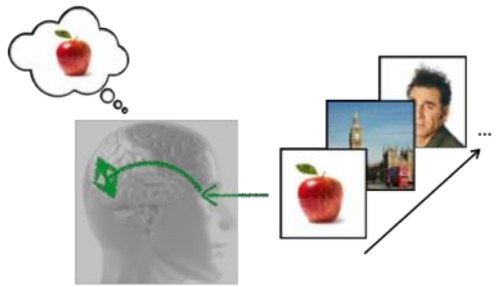
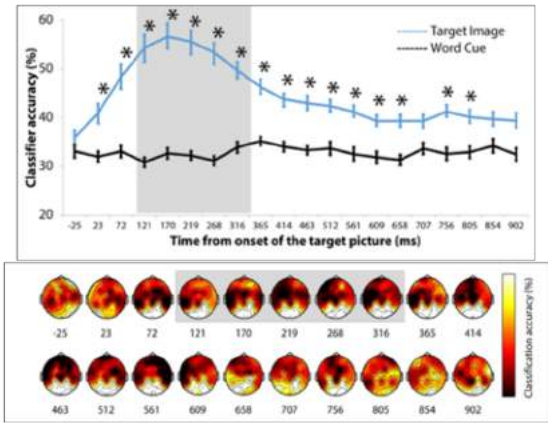
Memory Retrieval Analysis (from EEG only)

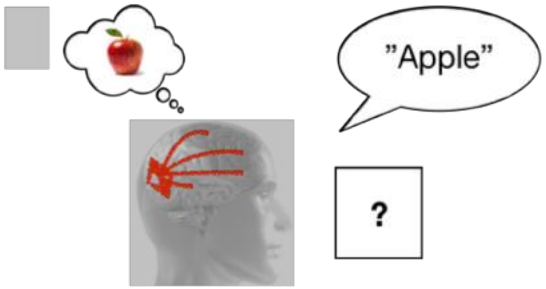
Multivariate Pattern Analysis of EEG data reveals the contents of memory retrieval (Bramão & Johansson (2018) eNeuro)

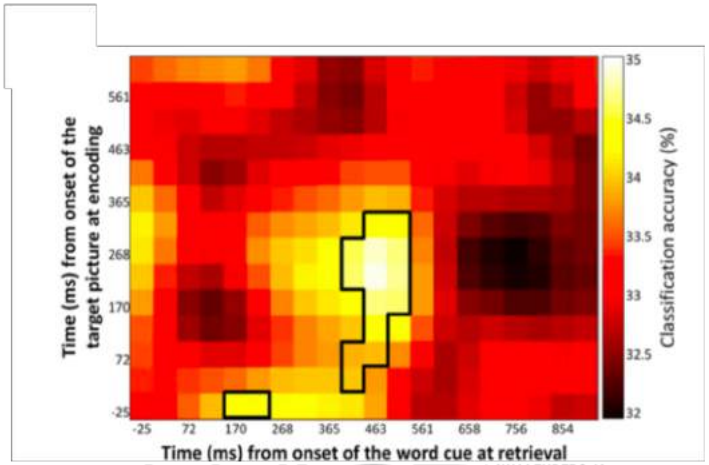
A. Encoding/perception





B. Memory retrieval





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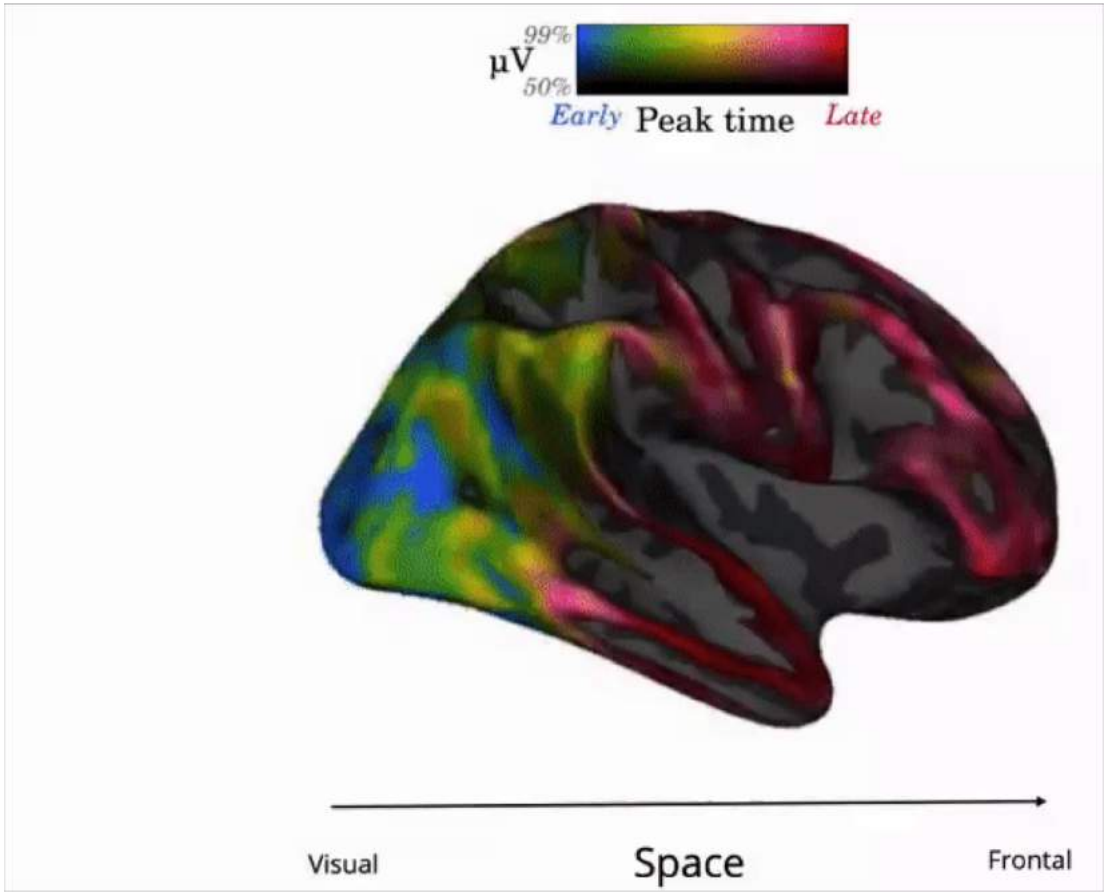
Flow of information



J-R. King, V. Wyart, *The Human Brain encodes a Chronicle of Visual Events at each Instant of Time*

bioRxiv 846576; doi: https://doi.org/10.1101/846576

See @jrking0 for tweet with movie. EEG -> source reconstruction

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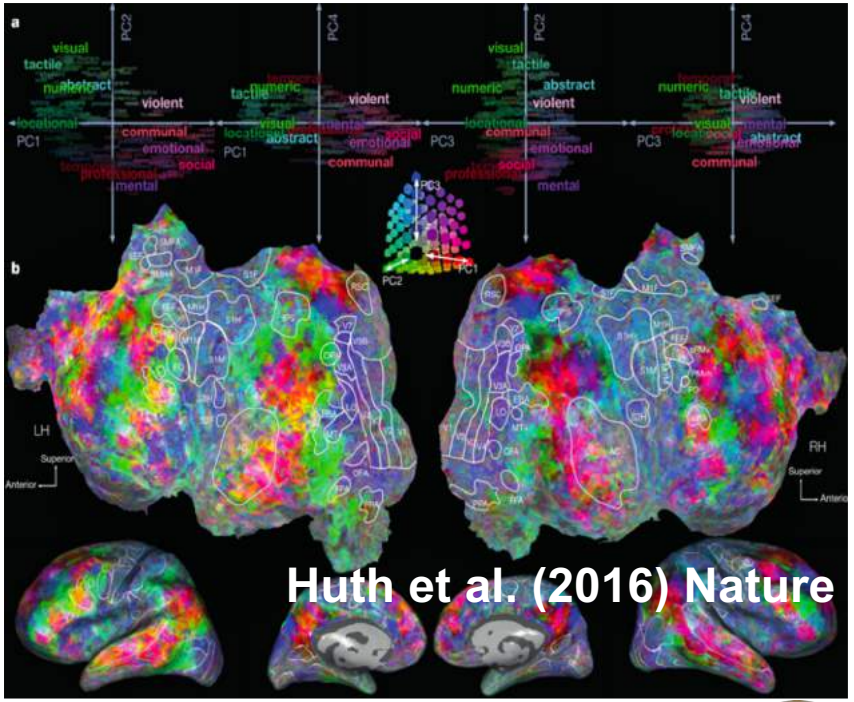
Recent Progress in Cognitive Modelling

fMRI + EEG



Huth et al. (2016) Nature

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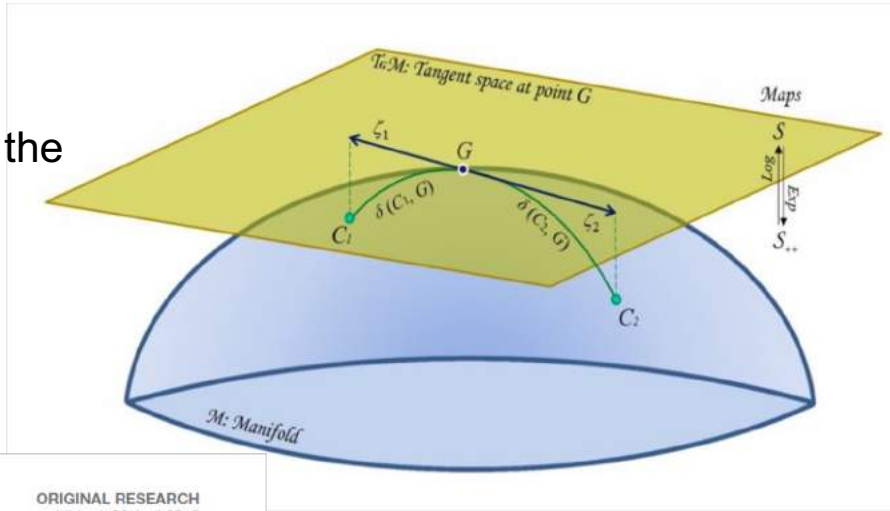
Tailored Distance Metrics

Riemannian Geometry-based methods

- Cleverly chosen metric captures properties of the EEG data manifold
- Winner in 5 recent BCI competitions



frontiers in Human Neuroscience

ORIGINAL RESEARCH
published: 26 April 2019
doi: 10.3389/fnhum.2019.00141

Check for updates

A Riemannian Modification of Artifact Subspace Reconstruction for EEG Artifact Handling

Sarah Blum, Nadine S. J. Jacobsen, Martin G. Bleichner and Stefan Debener*

Neuropsychology Lab, Department of Psychology, European Medical School, Carl von Ossietzky University of Oldenburg, Oldenburg, Germany

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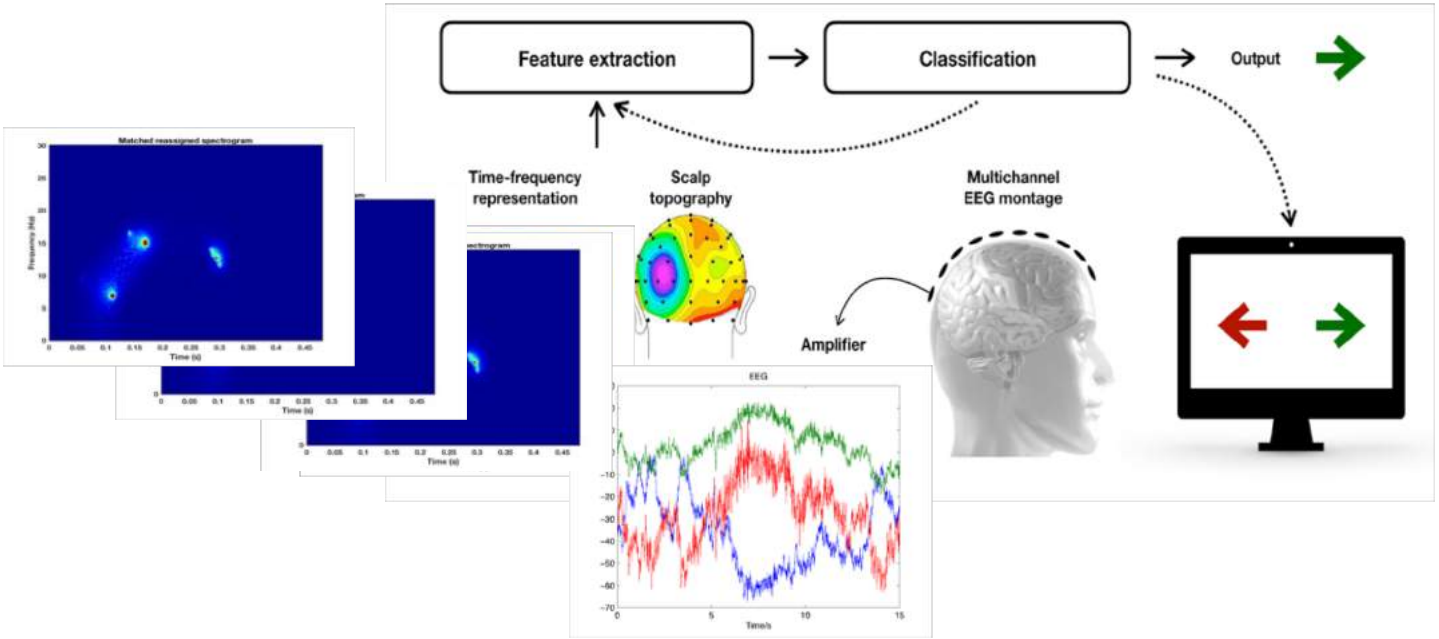
BCI 2.0 – feedback control



We investigate the use of **cognitive modeling** and **feedback control** to

- optimize **time-frequency and feature representations** for increased resolution and reliability
- increase learning speed using **transfer learning** and **dual adaptive control**

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