

Mining Event-related Brain Dynamics II



Scott Makeig Institute for Neural Computation University of California San Diego

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SCCN Open Source Software Tools

List of data processing extensions

Piug-in name 🏼 🗢	Version ©	Short plug-in description 0	Link Ø	Contact ¢	Comments ¢
rERP @	0.4	Estimate overlapping ERPs using multiple regression	Download of	M. Burns 🔮	User comments
LIND B	1.5	Linear MOdelling of EEG data	Download g	C. Pernet 🚮	User comments
x cormap dP	2.02	Cluster ICA components using correlation of scalp maps	Download g	S. Debener 🚮	User comments
S perioritation	1.01	Uses Bioelectromagnetism toolbox for ERP peak detection	Download of	D. Weber 🙆	User comments
Vield dP	1.05	Add/Edit dataset events	Download of	J. Desjardina 👸	User commercia
lioreta	1.10	Export and import data to and from LORETA software	Download (A. Delorme 🔠	User comments
inter.	1.02	Non linear filtering using IIR filter	Download g	M. Pozdin 🔠	User comments
std_envtopo	2.39	Plot STUDY ICA cluster contribution to ERP	Download g	M. Myskoshi 🕼	User comments
std_selectiCsByCluster @	0.10	Forward-project clustered ICs to channels (beta)	Download of	M. Myakoshi 👸	User comments
std_dpoleDensity 🖗	0.23	Plot STUDY ICA cluster clipole density (beta)	Download g	M. Myskoshi 🖪	User comment
std_ErpCalc	0.11	Test and visualize simple effects on ERP (beta)	Download g	M. Myskoshi 🗟	User comments
pveltopo	0.10	Plot topography of percent variance accounted for (beta)	Download of	M. Myskoshi 🗟	User comments
timOutlier g?	0.16	Trim outlier channels and datapoints interactively (beta)	Download of	M. Myskoshi 🗿	User comments
dean_rawdata B	0.31	Cleans continuous data using Antifact Subspace Reconstruction	Download g	Myakoshi and Kothe 🔒	User comments
APREStudio @	0.10	Cleans spiky antifacts using AFIt (beta)	Download g	Myskoshi and Mullen	User comments
Mutual_Into_Clustering	1.00	Group single dataset ICA components by Mutual Information	Download g	N. Bigdely 🚳	User comments
mass_unv@	130502	Mass Universate ERP Toolbox	Download of	D. Groppe 🚮	User comments
REDICA #	1.00	ICA regression based EOG removal	Download g	M. Klados 🚮	User comments
MARA dP	1.1	Multiple Artifact Rejection Algorithm	Download g	L Winkler	User comments
tete 🛃	1.6.1	Poutines for designing linear filters	Download of	A. Widmann 🕄	User comments
PACT	0.17	Computes phase-amplitude coupling for continuous data	Download g	M. Myskoshi 🔒	User comment
MRb (2	2.00	Remove IMRI artifacts from EEG	Download of	J. Dien 2 & R. Nazy	User comment

Many tools now available -- but still (?) a multicultural problem.Psychology.Biology.Physics/Math.S Makeig, 2012

What is EEG?

- Brain electrical activity
- A small portion of *cortical* brain electrical activity
- An even smaller portion of *total* brain electrical activity
- But a particular portion.
- Triggered and modulated in complex ways.
- With not well-understood functional significance.













Phase cones (Freeman) Avalanches (Plenz)



S. Makeig 2007









Blind EEG Source Separation by ICA

Information-based Signal Processing

Independent Component Dipolarity

Measured by residual variance not accounted for by the best fitting single (or dual) equivalent dipole model.





ICA separates *non-brain* effective source processes



J. Onton & S. Makeig 2006

... and also separates cortical brain IC processes



Julie Onton & S. Makeig (2006)





NEW! Handheld 3-D electrode position recording

(aka 'digitizing' the electrode montage)





Clement Lee & S. Makeig, 2018

get_chanlocs() interface – *post hoc* 3-D electrode location recording from a subject 3-D head image.

Blind EEG Source Separation by ICA









Blind EEG Source Separation by ICA

Spatial Navigation



Tunnel Task – A Passive Spatial Navigation Paradigm





Klaus Gramann & S. Makeig, 2010

Two parietal component clusters



Klaus Gramann et al., 2010

Medial prefrontal component cluster



Clusters distinguishing Turners & Nonturners





Visual Working Memory Task – Trial Summary



0.5 sec 2 sec 3 sec 3 sec 2 sec

Figure 1. Participants performed a Stemberg visual working memory task during EEG recordings. In each trial, appearance of an alerting fixation-cross cued trial onset. Participants then viewed an encoding stimulus containing either 1 or 3 dots (low-loads), or 5 or 7 dots (high-loads), attending the spatial positions of the dots for 2 s. The dots then disappeared from screen, beginning a 3 s maintenance period. Upon presentation of the probe stimulus, participants were asked to indicate, by button press, whether or not the location of the probe disc matched the location of any of the encoding stimulus discs. During the ensuing intertrial intersal (JTI) the screen was blank.

Lenartowizc et al., J. Neurosci., 2014

ADHD Working Memory



Lenartowizc et al., J. Neurosci., 2014



15 IC Clusters

ER 24214 St, 355 Ko)







GLA (157 D), HD 853



015(03.0,0010)







Ch 7 (181 Rs, 187 ICs)



Get (132 %, 159 IGs)



Cle 12 (144 6e, 308 ICe)





Ch 14 (170 b), 38P (Ch)



Cite 10 (177 Bit, 200 ICs)



Che 11 (130 Be, 138 ICe)



Clar 15 (218 lbs, 301 lCv)



Chi 15 (95K b), 907 (Ch)



Cla 13 (167 St, 201 Kin)



10 ERSP Canonical Correlation Filters



First Canonical Component, ERSP Filter



First Canonical Component, ERSP Filter



Blind EEG Source Separation by ICA

High-Resolution **EEG Source Imaging**



Z. Akalin Acar et al., 2016

SCALE-returned BSCR values for 9 subjects

SCALE applied to data from 9 subjects between 18-25 years old. Four-layer head models (scalp, skull, CSF, and brain) were derived from whole head MR images. Assumed conductivities: Scalp: 0.33S/m, CSF:1.79S/m, Brain: 0.33S/m The numbers of ICs used to run SCALE are shown in parentheses. *Skull conductivity* and *brain source patch distributions* were learned from the data. Skull conductivities are expressed as Brain/Skull Conductivity Ratio (BSCR):





Brain imaging during movement – How?

• Current advances in miniaturization, computer power, and informationbased signal processing mane possible anew meging modality:

→ Mobile Brain/Body Imaging (MoBI)

Brain/body

Concept:

Combine whole-head Eee, eaging gaze tracking, and whole-boody motion capture recording in a real-world 3-D environment.



Mobile Brain/Body Imaging

~1,000,000 GHz

Record what the brain does, What the brain experiences, And what the brain organizes.

S. Makeig 2007

MoBI Lab at SCCN, UCSD



Lab Streaming Layer software for synchronous multi-stream, multi-platform recording and feedback – freely available online (paper in progress): github.com/labs treaminglayer

Extensible Data Formal (xdf) for multimodal data collection and storage.



SNAP – a python-based framework running on Unity for control of simple o complex MoBI experiments.

MoBILAE – a Matlab-based multimodal data browser and pre-processing app.

S. Makeig, 2016



Measuring Musical Engagement Through Expressive Rhythm

How can we measure listeners' engagement?





- both Action & Emotion Inhibition



Spatial Navigation Experiment – the Audiomaze

- Navigate an 'invisible' maze in the dark.
- Receive directional audio feedback, not tactile feedback.
- Task: Explore the maze and learn its configuration.
- Test: Draw the maze.







1st Pass Navigation







3rd Pass Navigation



Central Posterior Independent Component Effective Source Cluster













Biological Psychology and Neuroergonomics Lab of Klaus Gramann @ Berlin Technical University

The Visiomaze

Subject's L- and R-eye 3-D visual feedback views

Brain imaging **natural cognition** -- actions & **interactions**



Imaging Human Agency and Social Interactions



S. Makeig, 2007

Gedeon Deak Lab @ UCSD Cognitive Science "Development of Shared Attention" – A Mother and Toddler MoBI Experiment



Now feasible – Low-cost MoBI Systems

Any EEG System Low-Cost MoBI



< \$500 Touchscreen

< \$1000 Full Body Wireless Inertial Motion Capture

LSL software drivers exist for all these (and more) devices



Cross-scleappee Aspects Scaptic and Oter transis bi-directional. Large Consciousness

Smaller

Scott Makeig 2007

Knowing



-15

-0.1

0

0.2

Time (s)

0.1

0.3

0.4

S. Makeig (2017)

0.5



Feeling



Julie Onton & Scott Makeig, Frontiers in Human Neuroscience, 2009

Willing



Imaging Human Agency

Mobile Brain/Body Imaging (MoBI)



Embodied Cognition & Agency





The Beginning

fEEG, BCI, MoBI, NFB, BrainStim ...

Can ICA reveal subject differences?



