

Mobile Brain/Body Imaging

MoBI

John Iversen

UCSD SCCN

EEGLAB Virtual Workshop, UCSD, June 14, 2021



MoBI Defined

- Mobile Brain/Body Imaging
- Dynamic brain measures synchronized to body motion capture and other behavioral and psychophysiological data streams
- Goal: Investigate brain activity supporting people actively interacting with their environment and/or with others. Gain new insights into the brain function underlying cognitive control of behavior and its consequences in 'real-world' situations.
- Overcomes movement and response restrictions of established imaging. Opens way to complex paradigms.
- Significance: Understand natural cognition. Development of robust human-machine interfaces including state assessment in active humans.



A brief history of MoBI

2006

Scott Makeig works with Howard Poizner on an EEG reach-to-touch task.

2007

TICS rejects invited paper on Mobile Brain/Body Imaging (“not realistic...”)



2009

‘MoBI Manifesto’ published in *Int. Journal of Psychophysiology*

2007

Klaus Gramann joins SCCN, starts working on a pointing task



2008

Dan Ferris spends his sabbatical at SCCN. Goes shopping for a treadmill.



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A brief history of MoBI...

2010

Gait Paper
Gait artifact rejection paper
Oddball Gait paper

2010

Standing – Walking –
Running task
@ U. Michigan



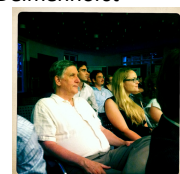
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2012

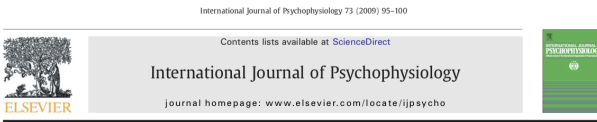
Stefan Debener “...takes
wireless EEG for a walk”

2013

1st International
MoBI Conference
Delmenhorst



Key Publications



Linking brain, mind and behavior

Scott Makeig^{a,b,*}, Klaus Gramann^{a,b}, Tzyy-Ping Jung^{a,b}, Terrence J. Sejnowski^{b,c,d}, Howard Poizner^b

Rev. Neurosci., Vol. 22(6): 593-608, 2011 • Copyright © by Walter de Gruyter • Berlin • Boston, DOI 10.1515/RNS.2011.047

Cognition in action: imaging brain/body dynamics in mobile humans

Klaus Gramann^{1,4,*}, Joseph T. Gwin², Daniel P. Ferris³, Kelvin Oie³, Tzyy-Ping Jung^{1,4}, Chin-Teng Lin^{4,5}, Lun-De Liao^{4,5} and Scott Makeig¹

of the 19th century (Fox, 1984), allowed for significant insights into human brain function and pathology, rapid development of new imaging methods and in

frontiers in
HUMAN NEUROSCIENCE

EDITORIAL

published: 19 June 2014
doi: 10.3389/fnhum.2014.00444

Toward a new cognitive neuroscience: modeling natural brain dynamics

Klaus Gramann^{1,2,*}, Tzyy-Ping Jung^{3,4,5}, Daniel P. Ferris^{6,7}, Chin-Teng Lin^{8,9} and Scott Makeig¹⁰



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Multiple Modalities

Eye tracking



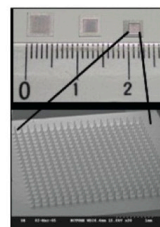
Dry or non-prep EEG



Motion Capture



Body sensory Network (ECG, GSR, Temperature, etc.)

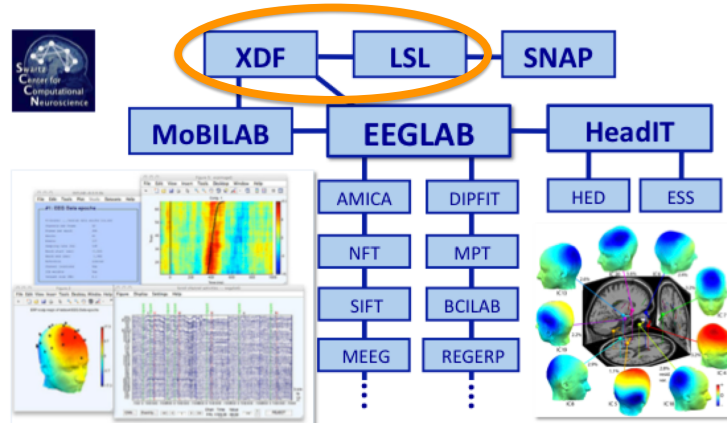


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Makeig, et al., *Int'l Journal of Physiology*, 2009.

Enabling Technologies

- Mobile Brain/Body Imaging (Makeig et al., 2009, Gramann et al., 2011, Gramann et al., 2014)
 - Open-source EEGLAB Ecosystem (sccn.ucsd.edu/eeglab/)



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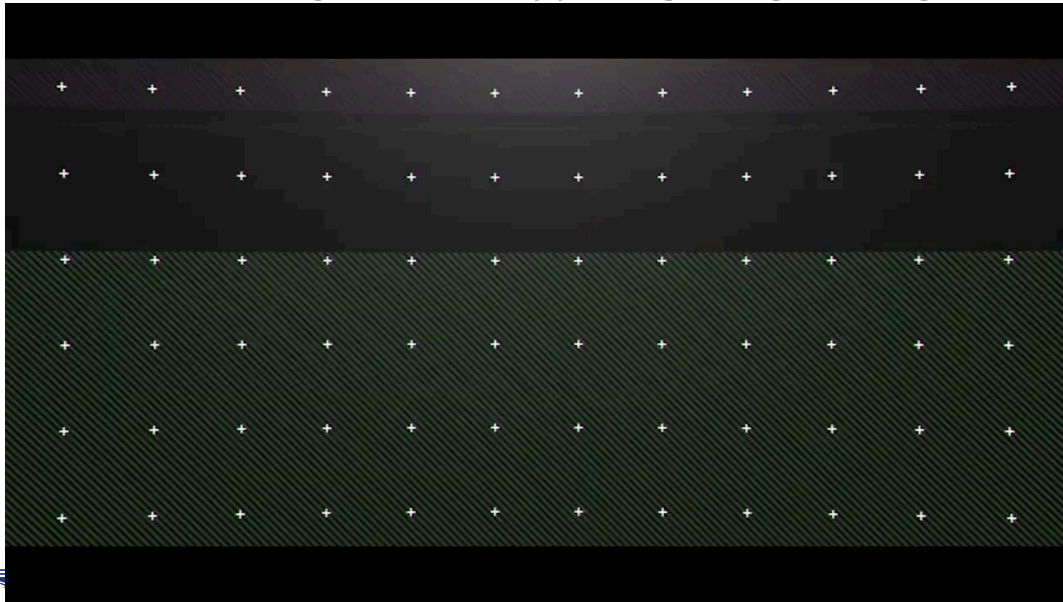
Examples of MoBI in action

- BCI & Wearables (Prior talks by Cedric and TP)
- Real-world decision making: VR
- Spatial navigation: Audiomaze
- Motor skill learning: JotM



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Real-World Cognition (Tzyy-Ping Jung & Ying Wu)



The *AudioMaze*: An EEG and motion capture study of human spatial navigation in sparse augmented reality

EJN, 2021

Makoto Miyakoshi¹  | Lukas Gehrke²  | Klaus Gramann^{2,3}  | Scott Makeig¹ | John Iversen¹

- Q: What are we missing by studying navigation using desktop/VR?
- A: NSF CRCNS Funded project testing real navigation using auditory and visual cues.



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BeMoBIL
Berlin Mobile Brain/Body
Imaging Labs



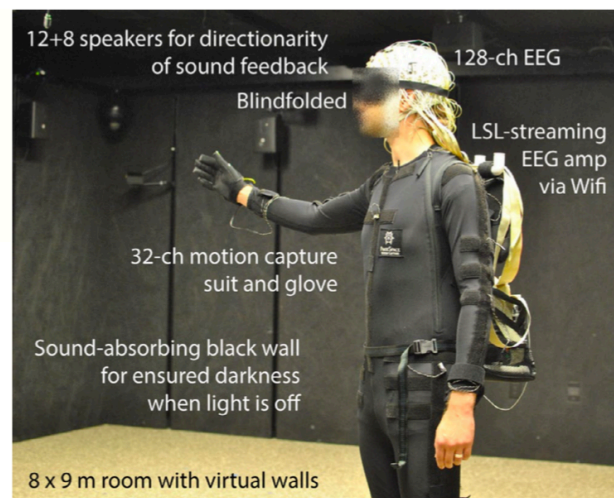
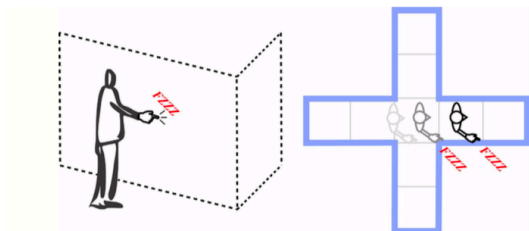
Questions

- How do we learn to navigate a new space?
- Navigational learning proceeds from egocentric information to the creation of an allocentric 'map'...
- What behavioral and brain processes underlie this transformation?
- Challenge: IRL spatial information is continuous and immediate.
- Solution: "Sparse" augmented reality – Atomize the learning of space

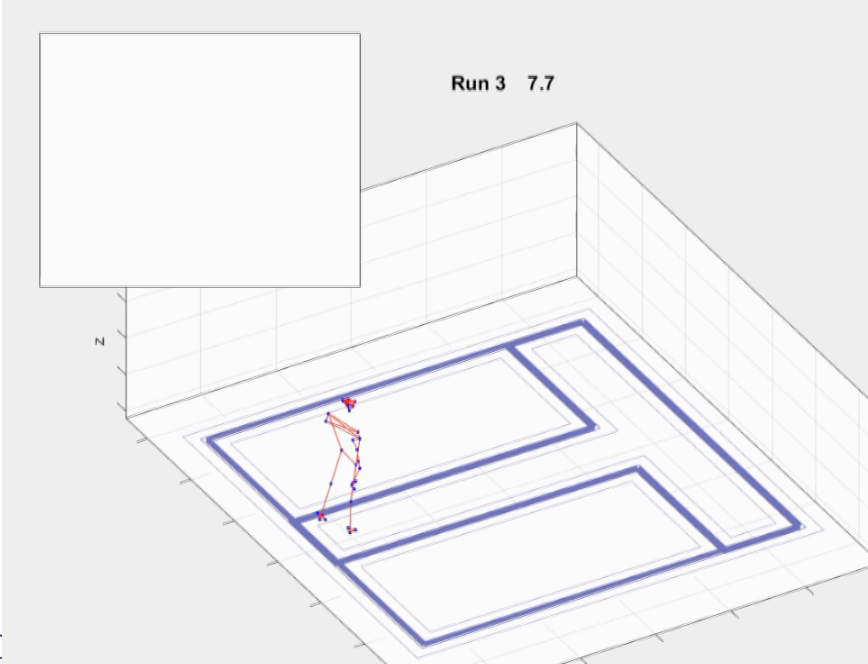


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Audiomaze

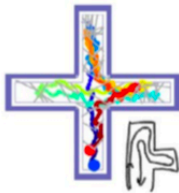


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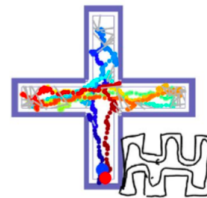
Trial 1



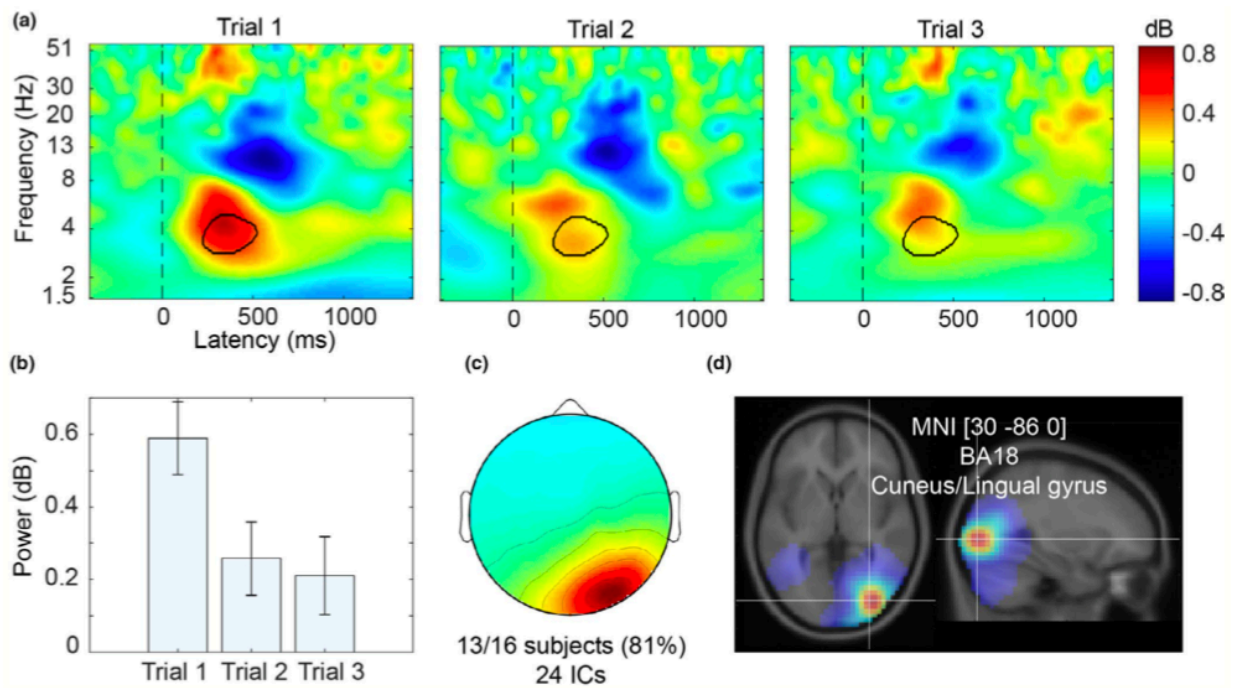
Trial 2



Trial 3

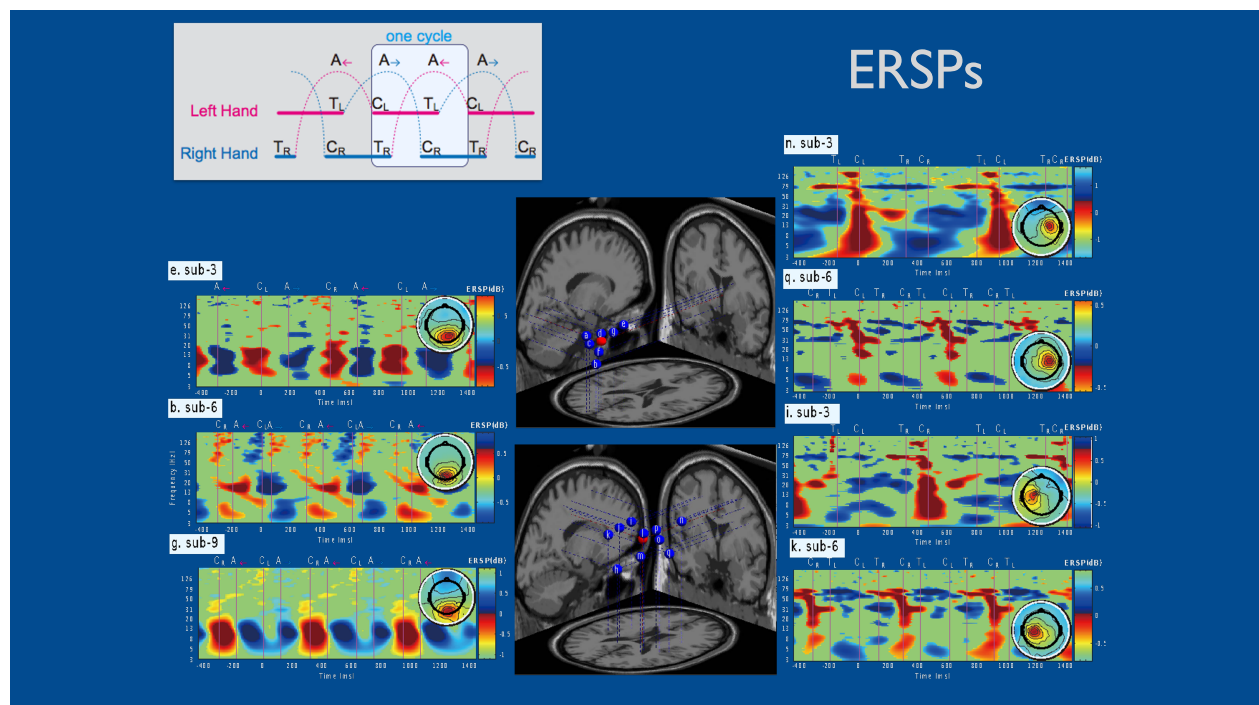
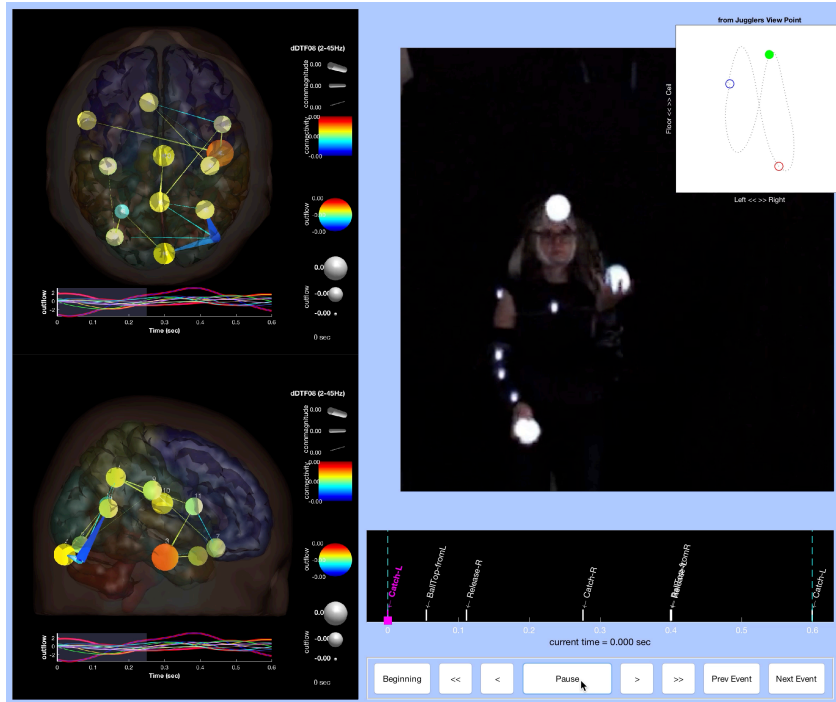


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MoBI of Juggling (Hiroyuki Kambara, Scott Makeig)







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Future Vistas for MoBI

- Ubiquitous EEG/opMEG/fNIRS outside of lab
- Lower cost, "DIY-MoBI"
- Study of interpersonal social interactions, group brain recording
- Expanded diversity
- Artifact rejection
 - New methods (dual electrode, Dan Ferris)
 - Need for standardization at all levels
- Need for creative, continuous dynamical, beyond event-based analyses
- Clinical applications



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