

Focus on neurophysiological evidence is still needed

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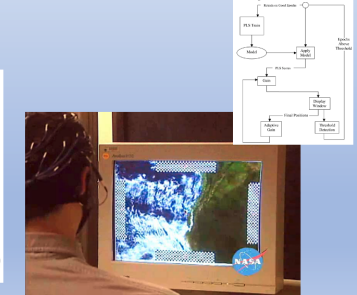
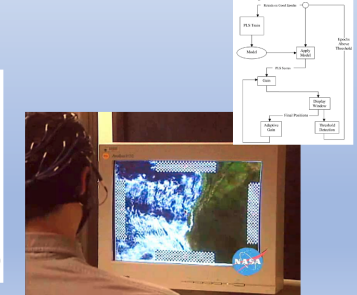
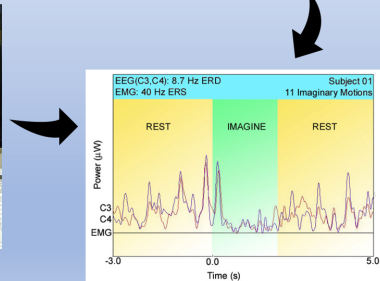
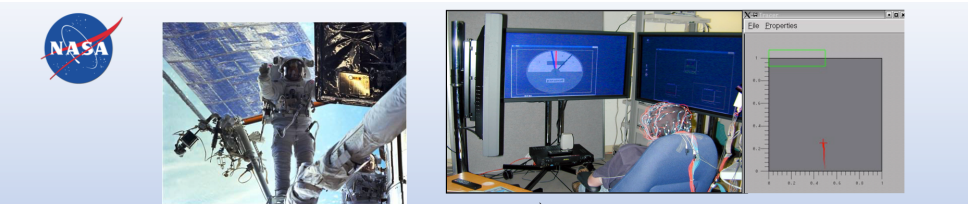




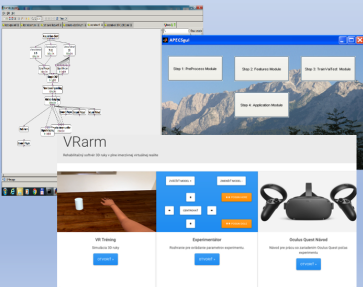
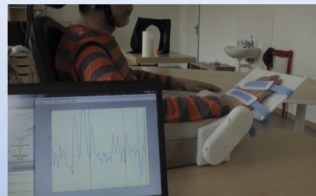
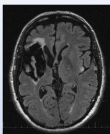
- Research at NASA Ames Research Center, starting at late 90's
- Multimodal Neuroelectric Interface Development
- Includes: BCI, EMG virtual keyboards and joysticks, sub-vocal speech, etc.
- Focus on Augmented Cognition and Human-computer Interactions
- Mental Fatigue, Cognitive Workload, Task Engagement, etc. detection and monitoring



- Research at the Slovak Academy of Sciences (SAS), 2013 →
- Focus on Individualized Neurorehabilitation of Upper Limbs of Post-stroke Patients
- Includes: Mirror-box Therapy, Robot-Assisted BCI, VR or Mixed Reality BCI



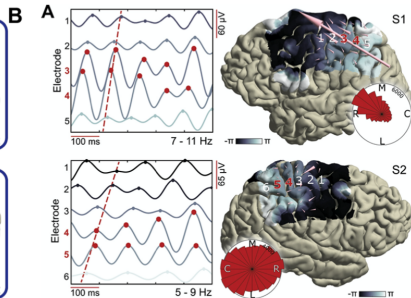
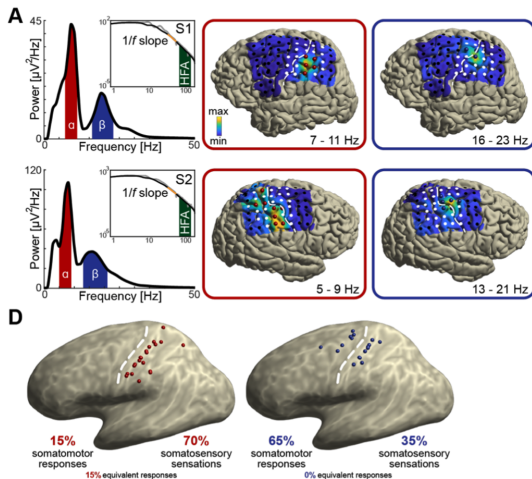
● ERD/ERS Robotic-BCI-FES & VR-BCI-FES Systems



Patient's perspective:

- Don't let classifier to drive me, let him to follow me!
 - Train what is needed for me, not what I am good at!
-
- Don't make it easy, don't make it hard!
 - I may spend more time with you, please don't make me bored!
 - Please, interact with me!

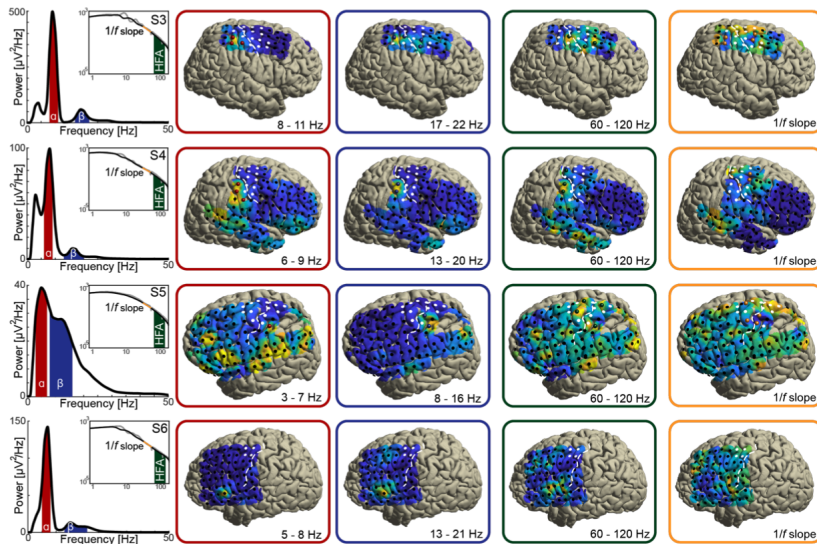
Search for Neurophysiological Evidence: Individuality, Space, Frequency



Alpha traveling waves

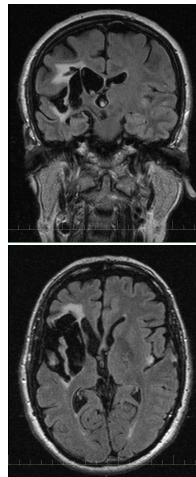
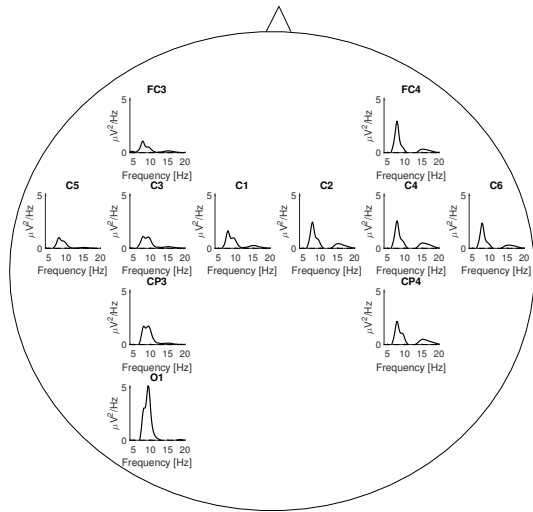
Stolk et al. Electrocorticographic dissociation of alpha and beta rhythmic activity in the human sensorimotor system, *eLife* 2019;8:e48065.
DOI: <https://doi.org/10.7554/eLife.48065>

Search for Neurophysiological Evidence: Individuality, Space, Frequency



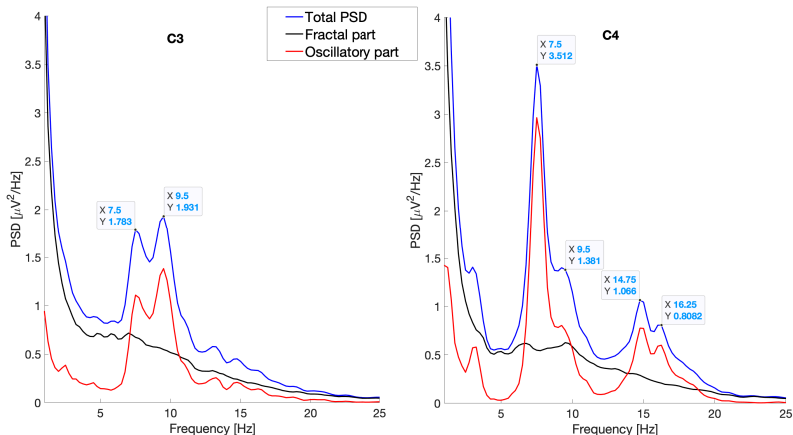
Stolk et al. Electrocorticographic dissociation of alpha and beta rhythmic activity in the human sensorimotor system, *eLife* 2019;8:e48065.
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Motivational Examples (space)



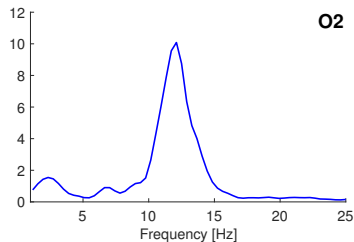
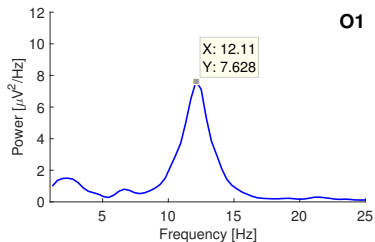
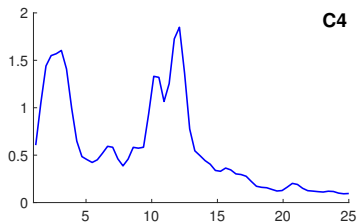
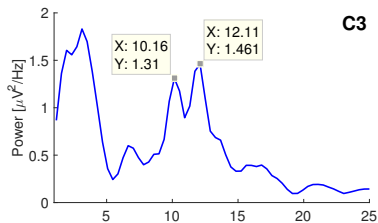
Averaged oscillatory part of the EEG power spectrum recorded during resting eyes-closed. A chronic stroke patient with ischemia in the fronto-temporo-parietal area on the left side

Motivational Examples (frequency)



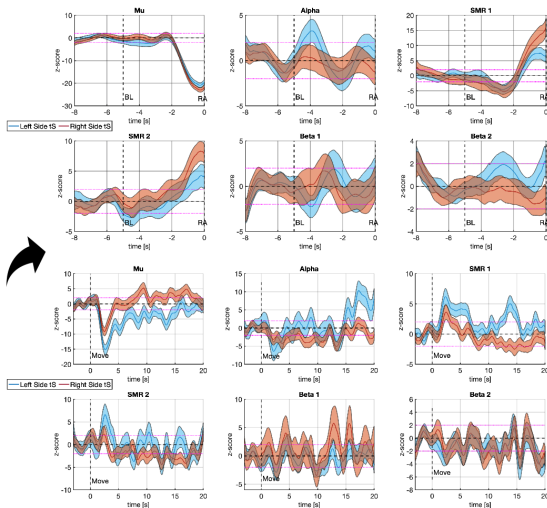
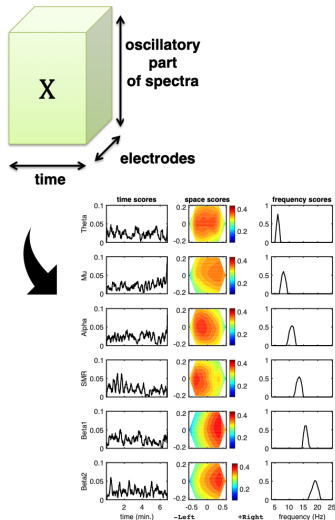
Decomposition of the power spectrum density (PSD) into the fractal (scale-free) and oscillatory components underlying the eyes-closed awake state recorded after mirror-box training. Plots represent means of the IRASA decomposition computed separately for 4-s-long overlapping segments of approximately two minutes long resting block at two central EEG electrodes C3 and C4. Frequencies were restricted to the range 1-25 Hz for the visualization purposes..

Motivational Examples (frequency)

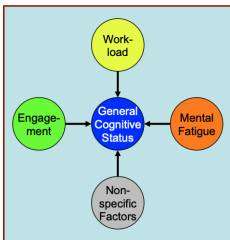


Tensor Decomposition into Unique Space-Frequency-Time Atoms

- Neurofeedback like control of time-scores of a given atom or atoms interactions - **interplay**

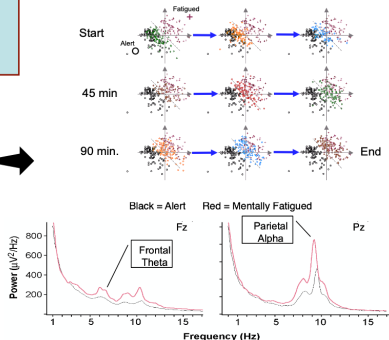
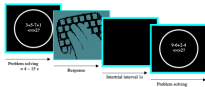


Cognitive Status Detection and Monitoring



- Longer-term projects sponsored by NASA and Army Research Office (ARO)
- Collaboration with UCLA

Mental fatigue monitoring



Lateralized Attention Network Test



- We developed the LANT for measuring selective attention in each hemisphere. It includes:
 - Conflict resolution
 - Spatial Cueding
 - Alerting
 - Inhibition of Action
- The LANT is sensitive to individual differences:
 - In Attentiveness and In Gender
 - In Personality (e.g., anxiety, empathy)
 - In Social Interactions, e.g.,
 - Anxiety in discussion
 - Conditions of teamwork
- Performance can be optimized by:
 - Adapting to the contemporary diurnal rhythms of the attentional networks in the two hemispheres
 - Providing individually emotionally relevant background and spatial cues
 - Modulating the attentional networks of the two hemispheres, e.g., by using
 - visualization / relaxation
 - EEG feedback

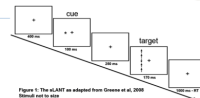


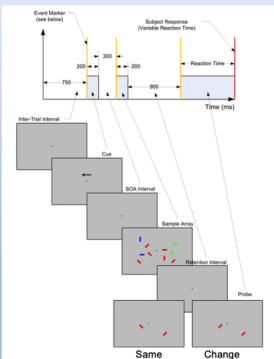
Figure 1: The LANT as adapted from Glines et al., 2000. Stimuli not to size



Cognitive Effects of VR: Visual Working Memory

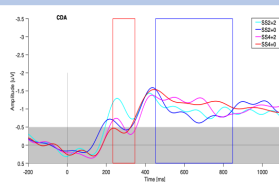
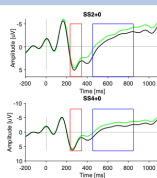
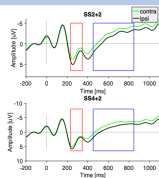
Contralateral Delay Activity (CDA)

The CDA is a negative slow wave sensitive to the number of objects maintained in visual working memory (VWM)



Lirkis CAVE

Proprietary designed the defense game focused on training VWM





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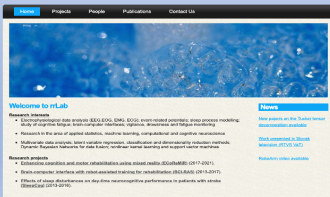


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