**New computational approaches to handle/model/integrate massive data streams**

Classical EEG analysis methods have been applied to investigate the processing of a secondary task while walking ([Gramann *et al.*, 2010](#_ENREF_9); [Gramann *et al.*, 2011](#_ENREF_10); [De Sanctis *et al.*, 2012](#_ENREF_3); [Debener *et al.*, 2012](#_ENREF_6); [De Sanctis *et al.*, 2014](#_ENREF_4); [De Vos *et al.*, 2014](#_ENREF_5); [Malcolm *et al.*, 2015](#_ENREF_15); [Malcolm *et al.*, 2017](#_ENREF_17)). Time frequency and time warping analysis has been able used to investigate power changes in frequency bands during the gait cycle ([Wagner *et al.*, 2012](#_ENREF_21); [Seeber *et al.*, 2014](#_ENREF_20); [Malcolm *et al.*, 2018](#_ENREF_16)). These studies have been made facilitated by the application of independent component analysis (ICA) to separate cortical signals from muscles and movement ([Delorme & Makeig, 2004](#_ENREF_7); [Gwin *et al.*, 2010](#_ENREF_11); [Nolan *et al.*, 2010](#_ENREF_18)). These approaches have been important in the development of the MOBI field but they are the tip of the iceberg of experimental and analysis possibilities.

In the controlled virtual reality environment there are a plethora of ways of recording different aspects of movement such as body tracking, object tracking, footfalls, auditory stimuli, visual stimuli, responses, eye tracking and many more. In the real world there is a wider range of stimuli and inputs to interact that can be recorded using head mounted cameras, microphones, accelerometers, gyroscopes and gps. All this data needs to synch with the neurological recordings with millisecond precision as to investigate neurological markers even a fifty millisecond jitter ([Butler *et al.*, 2017](#_ENREF_1)) in time that results in artificial reduction of evoked responses. It is not a straight forward to ensure that the timing is accurate, as different recording devices will have different sampling rates and reliability which have not been tuned for the fine precision required for evoked analysis. This can be addressed by using software such as, lab streaming layer ([Kothe, 2013](#_ENREF_12)) to combine and time stamp information from different sources such as body tracking data and video data.

The combination of all these different types will require new analysis approached to truly leverage the richness of the evoked or continuous data. To investigate time locked events adjacent response algorithm ([Woldorff, 1993](#_ENREF_23)) or group independent component analysis ([Eichele *et al.*, 2011](#_ENREF_8)) could be used extract evoked response of overlapping stimuli from different sources. To investigate the continuous signal two possible analysis approaches that have yield promising results in other neuroscience areas could be applied to the MoBI field. The first approach has used a spread spectral analysis to extract the temporal response function (TRF) from continuously varying visual information ([Lalor *et al.*, 2006](#_ENREF_14)), speech ([Lalor & Foxe, 2010](#_ENREF_13)) and multisensory information ([Crosse *et al.*, 2015](#_ENREF_2)). This method has also been shown to separate the temporal response function for multiple input signals ([O'Sullivan *et al.*, 2016](#_ENREF_19)). This would be extended to a rich environment to identify what aspects of the environment the participant is attending from different sensory information such as the sound of speech, the sunlight in the tree, the proprioceptive input from walking. The second approach uses ICA and LORETA for parsing the course of a continuous video ([Whittingstall *et al.*, 2010](#_ENREF_22)) to identify cortical locations with preference different facets of a complex stimuli. Finally, machine learning methods such as artificial neural networks trained on the different features of the data to extract information beyond what is considered in the more linear approaches. This kind of neural network could facilitate real time interaction and feedback.

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