

ERP decoding to classify self-made and externally generated errors

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Neurons encode environmental information in electrical pulses, or action potentials, and neuroscientists have spent many years unravelling the event-related potentials (ERPs) caused by sensory, cognitive and motor events. In the recent years, several studies have done the inverse pipeline, i.e., the ERPs have been decoded to predict the event that it is causing it. One example of this decoding procedure in cognitive neuroscience is the detection of errors. To perform successful goal-directed tasks, participants' unintended action outcomes, such as errors, must be detected as self-made so that they can readjust their behavior to not to repeat the same error in the future. Interestingly, this readjustment is different regarding the attribution of these errors to either internal or external causes. Previous studies have used ERPs to classify/decode error and non-error trials (Chavarriaga and Millán, 2010), and used them in brain-machine interface (BMI) applications. For instance, BMIs can decode the user's intentions from the ERPs, allowing the system to take corrective actions when errors are detected (Dal Seno et al., 2010; Ferrez and Millán, 2008; Schalk et al., 2000). Besides, ERP classification can be used to reduce the probability of future error repetitions, allowing the machine to learn the correct and unintended actions based on the humans perception and the cause of these actions (Artusi et al., 2011; Llera et al., 2011). In the present project, we want to explore the application of ERPs in response to self-made errors and externally generated errors, and to investigate the accuracy of decoders. We will use different ERP descriptors and classifiers, at a single-trial basis, to decode internal and external causes of errors. Furthermore, we will investigate its potential applicability, providing further insight of the usefulness of electroencephalography-based feedback methods, for designing new assistive technologies that could be monitored online to control distant artificial agents.