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Exploring distinct beta band activity representations during hand motor imagery

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Brain-computer interfaces (BCI) for motor-related tasks have traditionally relied on band-limited power changes as the classification feature of interest. This approach is based on seminal papers that described the first reliable non-invasively recorded neural markers for such tasks: event-related desynchronization (ERD) and synchronization (ERS) in the mu and beta frequency bands [1]. Recently, however, mounting evidence has suggested that beta band activity is neither sinusoidal nor sustained oscillations, but rather occurs as bursts [2]. These findings imply that the ERD/S patterns emerge only when studying trial-averaged activity and that signal power may thus not be the most appropriate neurophysiological marker to use in paradigms focusing on single-trial activity, like BCI. Instead, an alternative approach that describes beta burst rate modulations instead of beta power could be more sensitive for classification, as it may better reflect subtle, condition-specific changes.

To explore this hypothesis, we analyzed seven open EEG datasets contrasting “left” versus “right” hand motor imagery and available via the MOABB package [3]. We focused our analysis on channels C3 and C4 for each subject, and compared standard single trial classification approaches with a new burst detection and waveform analysis algorithm [4].

We show that classification features describing the rate modulation of bursts with distinct waveforms can be more informative than beta band power, and more reliable than conventional time-frequency based burst features such as overall burst rate, burst peak amplitude, and the temporal and frequency spans of bursts (Fig. 1). These results suggest the potential improvement in BCI classification accuracy and robustness one could achieve by considering such finer neurophysiological features. They also call for further exploration of the complex relationship between burst activity and signal power within the beta range.

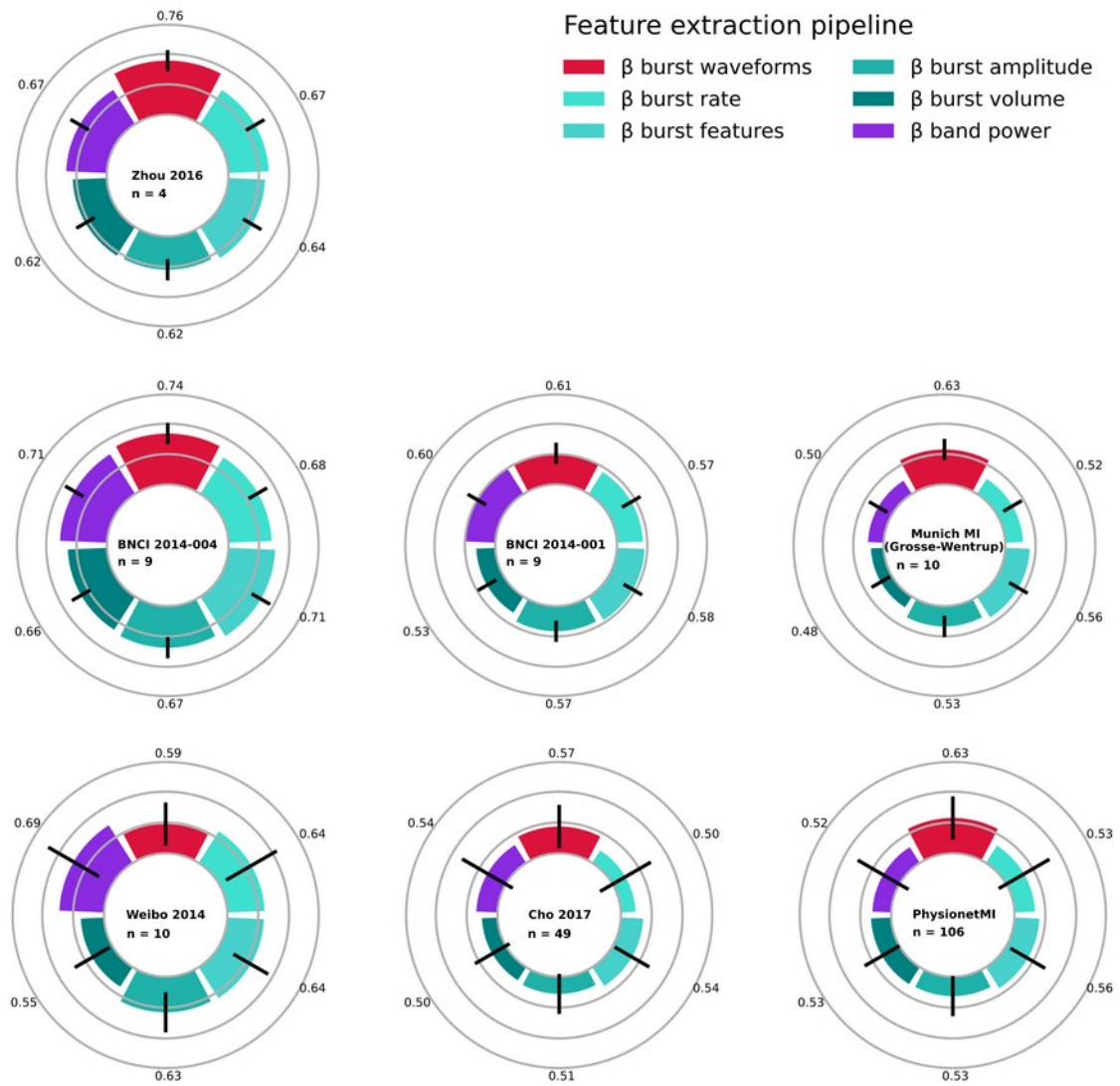


Figure 1. Average classification scores based on different feature extraction algorithms for seven open motor imagery datasets of “left vs right hand” tasks accessible via MOABB.

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