

## The detection of *Windows of Consciousness* in locked-in patients

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**Introduction:** In 2020, Kübler suggested the search for *windows of consciousness* (WoC) to increase the probability of establishing BCI-based communication with patients suffering from the complete locked-in syndrome (CLIS) [1]. Interestingly, some brain activity patterns which were found to be related to high BCI performance in CLIS patients [2] – which might indicate the existence of WoC – already fluctuate in patients with classical locked-in syndrome (LIS), thus before they enter CLIS [3]. Combined with known fluctuations in BCI accuracy in ALS patients more generally [4], this may imply the existence of WoC in LIS-patients. To detect WoC, we decided to investigate resting-state recordings preceding BCI sessions with regard to two neural measures of consciousness. We chose 1) the *Lempel-Ziv complexity* (LZC) which is said to indicate the information-richness of the current conscious experience [5] as well as 2) the *power-law exponent* (PLE) that numerically expresses the brain's arrhythmic activity [6]. The PLE thereby is, as elucidated in the *temporo-spatial theory of consciousness*, a measure for the *temporal nestedness* of the different intrinsic neural timescales at play – shown to be related to arousal [7].

**Materials, Methods and Results:** To detect WoC in LIS-patients, we analyzed resting-state EEG data, recorded prior to the use of a P300-based tactile BCI in the same session from a single locked-in ALS patient. We explored potential systematic relationships between the outlined measures of consciousness (LZC, PLE) with the respective BCI online accuracy achieved. We were able to show strong correlations between these metrics and the accuracy reached with our tactile BCI [8] (see Figure 1).

**Discussion:** Our results suggest a relationship between states of consciousness in LIS-patients, as determined by the outlined metrics, and the online accuracy of a tactile P300-based BCI. Though some of the correlations reached significance, these first results should be validated on a substantially larger data set.

**Significance:** The detected relationship could be used to infer WoC in (C-)LIS-patients, i.e., the optimal time periods to initiate BCI-based communication to increase BCI accuracy.

### References

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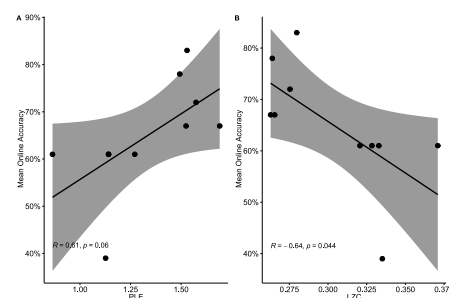


Figure 1. Pearson correlations between the power-law exponent (PLE) respectively Lempel-Ziv complexity (LZC) and the online accuracy reached with a tactile P300-based BCI.