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Spectro- temporal unfolding of temporal orienting of attention

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Abstract

All behaviors unfold over time, therefore, our ability to perceive and adapt our behavior according to the temporal constraints of our environment is likely a fundamental requirement for successful behavior (Nobre et al., 2007). Temporal preparation has been defined as our ability to anticipate and prepare an optimal response to forthcoming events in our environment (Nobre et al., 2007). Temporal preparation requires integration of different types of temporal information. On the one hand, information can be provided by temporal predictions, i.e. temporal orienting of attention. On the other hand, information can be afforded by the duration of the previous temporal events, namely the sequential effects (e.g., Capizzi et al., 2012). In this project we are focusing in the time-frequency analysis during the delay period (i.e., foreperiod) from the cue onset until the target onset at the short interval. We followed the results of Capizzi et al.'s (2013) study which showed that the CNV component was increased in the delay period when the previous foreperiod was short as compared to long (Cappizi et al., 2013).

Recent studies are concerned with the question of how oscillatory brain activity can provide a mechanism for regulating our temporal behavior (Cravo et al., 2011; Praamstra & Pope, 2007; Rohenkohl & Nobre, 2011). Oscillatory brain activity may be one of the mechanisms underlying the operation of different brain areas during cognitive functions (Buzsaki, 2006). When brain activity is recorded at the level of neural populations, the activity assumes a rhythmic temporal structure. Spectral analysis or time-frequency analysis is the study of brain rhythms. Using time-frequency analysis one can characterize the modulation of certain brain rhythms as those unfold in time. Additionally, different brain regions can engage in synchronized brain activity in certain frequency bands. Such synchronization may support inter-areal communication, which is likely fundamental to many of the cognitive functions producing behavior. Studying brain rhythms therefore has the potential of revealing mechanisms underlying cognitive function and behavior (Fries, 2009).

Previous studies in the field of temporal preparation (Cravo et al., 2011; Rohenkohl & Nobre, 2011) have investigated oscillatory brain activity and how it is modulated over the time intervals in which target events are expected. Specifically, desynchronization of low frequency power (<30Hz) has been documented following the time course of predictable time intervals. In this project, we

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were interested in investigating the spectro-temporal profile of both temporal orienting and the sequential effects during the preparatory interval (foreperiod). Time/frequency analyses was focused on epochs locked to the cue onset and compared EEG activity related to early vs. late temporal expectations (temporal orienting) and EEG activity related to previous short vs. previous long foreperiods (sequential effects).

With the aforementioned approach we aim to clarify whether or not sequential effects and temporal orienting effects are mediated by the same brain activity. The behavioral data from the previous study of Capizzi et al. (2012) indicated that temporal orienting and sequential effects are different aspects of temporal preparation and that sequential effects are related to automatic rather than to controlled processing unlike the temporal orienting effect. Time frequency analysis was performed in a total of fourteen subjects; cue locked analysis showed that when an early cue is followed by a short interval there is higher power in lower frequencies as compared to the power when a late cue is followed by a short interval. These results signify a difference in the power representation of the temporal preparation for explicit cuing compared when temporal preparation is guided by the presentation of a regular rhythm suggesting the involvement of dissociable mechanisms

Keywords: EEG; Attention; Temporal orienting; Oscillation

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