EEG alpha power desynchronization during sentence planning is linked to partial overlap in syntactic configurations

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Virtually all theories of grammar assume that linguistic expressions share partial syntactic configurations, modeled by derivation [1] or inheritance [2] mechanisms. Sentences like *"The rabbits eat the carrots", "The cat sleeps"*, and *"The mayor gives the toys to the children"*, e.g., all share the initial structure *NP V…* and thus exhibit partial overlap in their syntactic configurations. It remains open whether these partial overlaps are only computational patterns (in Marr's sense) or whether they are also neurally relevant [3,4]. To explore whether overlaps are neurophysiologically detectable during sentence production, we conducted a combined eye tracking and EEG picture description experiment [5] in Hindi. Here, we focus on the dynamics of event-related desynchronization (ERD) in the EEG alpha band (8-13 Hz) during relational and structural encoding phases of sentence planning [6]. Alpha ERD is associated with a wide range of functions, including syntactic and sentence-level processing during comprehension [7,8] and more general memory and attentional processes [9,10]. Our study constitutes the first exploration of the role of alpha ERD in sentence planning. Hindi is especially suited to study the effect of overlap in syntactic configurations in sentence planning because this language exhibits a split-ergative case marking system [11]. Subjects of transitive sentences are unmarked (*NP-Ø*, nominative) in imperfective aspect, but they carry overt case marking (*NP-ne,* ergative*)* in perfective aspect. While nominatives share the initial configuration $NP\text{-}Ø_{NOM}\ldots$ with intransitive sentences and passives, the ergative configuration $NP\text{-}ne_{ERG}\ldots$ is limited to transitive perfective sentences. We hypothesized that alpha ERD during structure planning should be sensitive to this difference in initial partial overlaps if they are neurally implemented. Fifty Hindi speakers described pictures of events using transitive SOV sentences with nominative or ergative subjects, while EEG was recorded (between subjects, $N = 25$ per group). Analyses of the time course of alpha band power changes during structure planning phases (0-1200 ms after stimulus onset [12]; speech onset was always > 1500 ms) revealed larger ERD (between 400 and 1200 ms, relative to a pre-trial baseline) for sentences with nominative subjects. The effect was distributed broadly over central and posterior electrode sites (based on a combination of growth curve regression and model trees [13,14], statistically controlling for nuisance variables, including speech onset and NP length). Thus, alpha ERD responses were stronger when the initial syntactic configuration of a sentence overlapped with that of other sentence structures ($NP\text{-}Ø_{NOM}\ldots$) than when it was initially unique ($NP\text{-}ne_{ERG}\ldots$). Our findings suggest that the role of alpha ERD in language production extends beyond supporting individual word retrieval [15]. More generally, our results demonstrate that partial overlaps between syntactic configurations are relevant for the neurocognitive processes underlying sentence planning, possibly because planning configurations with greater initial overlap increases attentional and selectional demands on speakers [16].

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