

Bilingualism and Executive Functions: ERP Evidence and Source Reconstruction of Conflict Processing in a Stroop Task

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Executive functions are necessary for the coordination and control of cognitive operations to reach specific goals. In the present study, we investigated whether the increased capacity of bilinguals to manage inhibition due to frequent code switching has an effect on conflict detection and resolution. Different models of bilingual language processing discuss how selection and inhibition of languages is carried out. Among them, the Inhibitory Control (IC) model by Green (1998) postulates a level of general inhibitory control implied in language selection and inhibition as well as in non-linguistic domains. To examine the capacity to resist interference, the classic Stroop task (Stroop, 1935) constitutes a critical test as two competing processes, i.e. a highly automatic linguistic process (reading) and a controlled process (colour naming), are simultaneously involved. To investigate the neuronal correlates of Stroop interferences, an event-related potential (ERP) experiment was designed. Twenty highly proficient successive French-German bilingual adults performed a manual version of the Stroop task in their first (L1) and second (L2) languages. In addition, 20 French monolingual adults were tested in their L1. In addition to the usual congruent, incongruent and neutral experimental conditions, a negative priming condition was included. Negative priming trials are incongruent trials whose print colour equals the colour word in the preceding incongruent trial. Therefore, inhibition applied on the colour word of the previous trial has to be overcome in order to respond to the print colour in the negative priming trial. Descriptively, whereas behavioural data showed shorter response times in bilinguals, no advantage of bilingualism was observed on the Stroop effect size. ERP data revealed a larger negative deflection in the negative priming compared to the congruent condition in the time window 200-300 ms (N200 effect) at centro-parietal electrodes, but only for monolinguals. This early negativity is thought to reflect overcoming of inhibition. Moreover, the negative priming condition was associated with a centro-parietal N400 effect of similar size for bi- and monolinguals. The N400 effect is discussed to reflect conflict detection or resolution. Analysis on the activity of neuronal sources replicated the anterior cingulate cortex (ACC) as a main neuronal generator of the Stroop effect. The ACC source waveforms showed a numerical difference between the negative priming and the congruent condition occurring slightly later for monolinguals (550-650 ms) than for bilinguals (500-600 ms). Further analyses on the two languages of bilinguals showed reduced behavioural and neurophysiological Stroop interference in L2 compared to L1 (reduced N400 effect in L2). These findings support the “temporal delay assumption” formulated by Dijkstra & Van Heuven (2002). Taken together, the present data reinforce the idea that multiple language use improves efficacy in resolving cognitive conflict. The results of the present study lend support to psycholinguistic models postulating a higher-order level of top-down inhibitory control involved in bilingual language processing. Moreover, our data convey information on the temporal decomposition of cognitive conflict processing. A bilingual advantage can be found not only for current inhibition but also for the flexibility necessary in overcoming of inhibition.

References

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