

Interaction between Cognitive Control and Language Processing in Non-Fluent Aphasia

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Abstract : Aphasia can be defined as a weakness in accessing linguistic information. Accessing linguistic information is strongly related to information processing, which in turn is associated with the cognitive control system. According to the literature, a deficit in the cognitive control system interferes with language processing and contributes to non-fluent speech performance. The aim of our study was to explore this hypothesis by investigating how cognitive control interacts with language performance in participants with non-fluent aphasia. Cognitive control is a complex construct that includes working memory (WM) and the ability to resist proactive interference (PI). Based on previous research, we hypothesized that impairments in domain-general (DG) cognitive control abilities have negative effects on language processing. In contrast, better DG cognitive control functioning supports goal-directed behavior in language-related processes as well. Since stroke itself might slow down information processing, it is important to examine its negative effects on both cognitive control and language processing. Participants (N=52) in our study were individuals with non-fluent Broca's aphasia (N = 13), with transcortical motor aphasia (N=13), individuals with stroke damage without aphasia (N=13), and unimpaired speakers (N = 13). All participants performed various computer-based tasks targeting cognitive control functions such as WM and resistance to PI in both linguistic and non-linguistic domains. Non-linguistic tasks targeted primarily DG functions, while linguistic tasks targeted more domain specific (DS) processes. The results showed that participants with Broca's aphasia differed from the other three groups in the non-linguistic tasks. They performed significantly worse even in the baseline conditions. In contrast, we found a different performance profile in the linguistic domain, where the control group differed from all three stroke-related groups. The three groups with impairment performed more poorly than the controls but similar to each other in the verbal baseline condition. In the more complex verbal PI condition, however, participants with Broca's aphasia performed significantly worse than all the other groups. Participants with Broca's aphasia demonstrated the most severe language impairment and the highest vulnerability in tasks measuring DG cognitive control functions. Results support the notion that the more severe the cognitive control impairment, the more severe the aphasia. Thus, our findings suggest a strong interaction between cognitive control and language. Individuals with the most severe and most general cognitive control deficit - participants with Broca's aphasia - showed the most severe language impairment. Individuals with better DG cognitive control functions demonstrated better language performance. While all participants with stroke damage showed impaired cognitive control functions in the linguistic domain, participants with better language skills performed also better in tasks that measured non-linguistic cognitive control functions. The overall results indicate that the level of cognitive control deficit interacts with the language functions in individuals along with the language spectrum (from severe to no impairment). However, future research is needed to determine any directionality.

Keywords : cognitive control, information processing, language performance, non-fluent aphasia

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