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Response inhibition is an important cognitive control function, which is required for suppressing prepotent but inappropriate responses. Using functional magnetic resonance imaging (fMRI) this function has been previously studied with Go/Nogo tasks. In order to induce a prepotent tendency to respond, the Nogo condition set the frequency of response trials as high as 80%, requiring inhibition in only 20% of trials. This allows the direct comparison of brain activation elicited by rare inhibition trials with the baseline activation and the activation elicited by frequent response trials. In contrast to previous studies, we have developed a Go/Nogo paradigm, which allowed imaging the neural correlates of response inhibition in three hierarchical levels. The brain activation for rare inhibition trials was contrasted with 1) the baseline activation, 2) the frequent response trials activation, and 3) the rare response trials activation.

The comparison rare inhibition - baseline showed a strong activation of the pre-supplementary motor cortex along with a wider fronto-posterior network, featuring the inhibition but also target detection necessary for completion of the task. The comparison rare inhibition - frequent response showed right-sided fronto-parietal activation, which represented the network lateralization for inhibition when comparing frequency-unbalanced trials. These first two comparisons largely replicated previous studies contrasting events of different frequencies in order to maintain a prepotent tendency to respond. The latter yielded the advantage of controlling for stimulus frequency, while maintaining a prepotent response tendency, and might thus have helped to isolate the neural correlates of response inhibition. In contrast, the comparison rare inhibition - rare response presented a more prominent activation in left than right ventrolateral prefrontal cortex. In addition, this contrast revealed strong activation of a subcortical brain region corresponding to the subthalamic nucleus. Trait impulsivity measured by the Barratt Impulsivity Scale correlated positively with activation in the left ventrolateral prefrontal cortex and the subthalamic nucleus, suggesting the need for stronger recruitment of these brain regions in impulsive individuals.

In summary, our results point to the left in addition to the right ventrolateral prefrontal cortex as well as the subthalamic nucleus as critical brain regions for response inhibition and impulsive traits.

Keywords: Impulsivity, Response inhibition, Go / Nogo, Prefrontal cortex, Inferior frontal gyrus, Subthalamic nucleus