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Inhibitory control training induces cortical thickness changes linked to global/local visual abilities in children

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Introduction

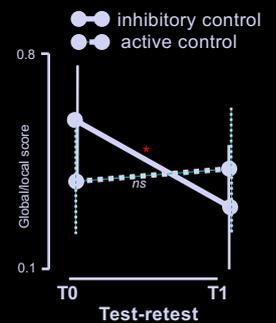
Visual environments are composed of global shapes (e.g. the forest) and local details (e.g., the trees) that compete for attentional resources (Navon, 1977; Krakowski et al., 2015). In adults, when local and global information are in conflict, global information must be inhibited to process the local ones (Poirel et al., 2014). Children, who present a weaker bias toward global visual information, have also to inhibit the local information during global processing (Krakowski et al., 2018). The present work used for the first time a longitudinal design to test the effect of an individualized inhibitory control computerized tactile device adaptive training (five weeks) on cortical thickness changes linked to global/local visual abilities in children.

Method & Results

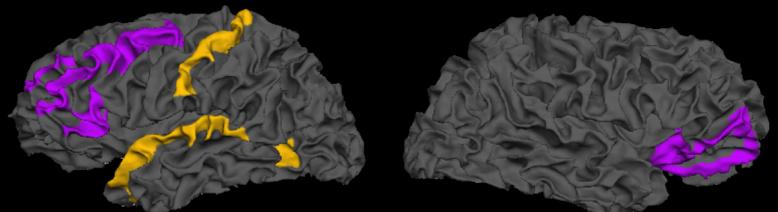
Ten years-old children (N=36) were randomly assigned to an inhibitory control (N=17, color word stroop and stop signal tasks) or an active control (N=19, knowledge and vocabulary based tasks) training group. In the pre- and post-training sessions, children performed a classic global/local selective visual attention task. During two blocs of 24 trials, participants had to focus their attention to one level (global or local) while ignoring the other, and they had to discriminate between two types of targets (H or S). Trials were either consistent (same target at both levels) or inconsistent (the different targets appeared at the two levels). Children also participated to a MRI session in a 3-Tesla MRI scanner. Mean cortical thickness values were extracted with Freesurfer software using the Destrieux Atlas (2010) for 30 of children who participated in this study (N=14 for inhibitory group and N= 16 for active control group) .



Standardized mean difference indexes were computed from global/local task RTs to obtain a global advantage score and a global interference score (Cohen's *d*, see Gerlach & Poirel, 2018) . The 2 (group : inhibitory control ; active control) x 2 (scores: global interference ; global advantage) x 2 (test-retest : T0 ; T1) repeated-measures ANOVA revealed a test-retest X group interaction ($p=.028$), characterized by a better general gain of visuo-spatial abilities between T0 and T1 for the inhibitory control group ($p=.004$) than for the active control group ($p=.69$).



We observed that in comparison to the control group, the better abilities to deal with interference from local information after inhibitory control training was associated with changes in cortical thickness in several prefrontal regions (insula, inferior, middle and orbital, all results reported are statistically significant at 0.05). On the other hand, the better abilities to deal with interference from global information after inhibitory control training was associated with changes in cortical thickness in postcentral, superior temporal and occipital regions.



Significant variation between T0 & T1 associated with :
Global interference dealing efficiency
Local interferences dealing efficiency

Discussion

Behavioral results revealed that children's performances during global/local visual attentional task improved from the pre- to the post-training more in the inhibitory control group than in the active control group. The present study is the first to evidenced the beneficial impact of inhibitory control training on neural levels for visuo-spatial abilities in children. In particular, inhibitory control training allow (1) a posterior neural plasticity linked to the ability to deal with conflicting global visual information, and (2) an anterior neural plasticity linked to the ability to deal with conflicting local visual information. In agreement with the ontogenetic view regarding global/local processes (i.e., local precedence effect that evolve with age to a global precedence effect, see Poirel et al., 2008), these results suggests an involvement regarding global interference dealing efficiency that appeared first in posterior brain regions, and an involvement regarding local interference dealing efficiency that is present in anterior brain regions, in line with the view of a postero-anterior gradient in brain plasticity (Sowell, 2004) after inhibitory control training.



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