Developmental changes in brain activation and connectivity within the fronto-parietal network

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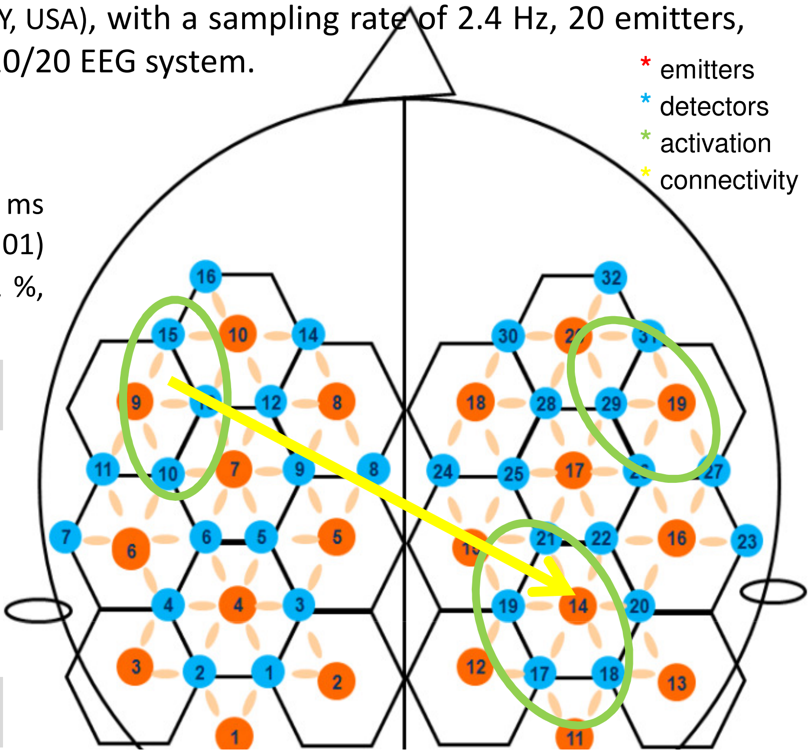
Developmental changes have been reported for brain activation and connectivity, with the frontal lobe being a key structure in cerebral maturation. We applied a response inhibition task in 20 children, aged from 4-6 years (mean age 4.7 years) and 20 adults (mean age 26.3 ± 4.3) using near infrared spectroscopy (NIRS). We combined task-induced activation maps and functional connectivity by extracting the complete time courses of the significantly activated channels and by using them for coherence analysis. Functional connecitivity is defined as the correlations between spatially remote brain activation. Partial coherence identifies the direct relation between two brain regions, with the influence of the rest of signals on that relations statistically removed.
We used DYNOT NirX (Medical Technologies LLC, NY, USA), with a sampling rate of 2.4 Hz, 20 emitters, 32 detectors. Positions were adapted from the 10/20 EEG system.



Behavioral results

Children had longer reaction times (rt_{adults}=465.9 ms ± 49.2 ms, $rt_{children}$ = 878.4 ms ± 192.7 ms, t= 9.2, p<.01) and committed more errors ($rate_{adults}$ = 1.7 ± 1.2 %, $rate_{children}$= 9.8 ± 4.7%, t= 7.5, p < .01).

Brain Activation (deoxy-Hb):

Subjects activated significantly a fronto-parietal network while performing the go nogo task (right frontal: e19_d26, e19_d29, e19_d31, e20_d29, left frontal: e9_d10, e9_d15, right parietal : e14_d17, e14_d18, e14_d19, e14_d21, $p_{corr} < .05$).

Functional Connectivity (coherence):

The analysis of time courses revealed weaker coherence between left frontal and right parietal areas in children (e9_d15-e14_d21, e10_d15-e14_d21, e9_d10-e14_d21, e10_d15-e14_d21, $p_{corr} < .05$) in high frequencies (0.88 and 1.04 Hz).

Developmental studies of functional connectivity report changes in networks involving frontal areas during resting-state fMRI as well as task-fMRI (Fair et al. 2009, Hare et al. 2008). The findings regarding weaker interhemispheric connectivity might be due to the ongoing development of the corpus callossum at the age of four (for review see Giedd et al. 2008).
To date, there are a few developmental studies that combine activation maps and functional connectivity measures. However, one might conclude that it might give new insights into developmental processes and interhemispheric connectivity within the fronto-parietal network.