ICCS Abstract

Title: Forethought experience in ADHD: a study of the neural and behavioral correlates.

Authors

Poissant, H. -1; Mendrek, A. - 2; Senhadji, N, -3; Rapin, L. -1
1- Université du Québec à Montréal 2- Université de Montréal 3- Institut Universitaire de Gériatrie de Montréal

Abstract

Introduction: Attention-deficit hyperactivity disorder (ADHD) has been associated with subtle neuroanatomical anomalies, as well as deficits in working memory (WM) and behavioral inhibition (Barkley, 1997). Two important components of the WM, hindsight and forethought, have been proposed to be impaired in ADHD, but not adequately studied. Thus, the purpose of the present investigation was to delineate the neural correlates of forethought in ADHD children relative to typically developing (TD) individuals. The existence of a prefrontal dysfunction associated with behavioral inhibition and executive control deficits in ADHD and the link of forethought to WM and inhibition (Barkley, 2011), has lead us to hypothesize that children with ADHD will show atypical patterns of prefrontal activations while performing a task related to forethought.

Methods: Twenty-one TD and 23 ADHD adolescents underwent neurocognitive testing and functional magnetic resonance imaging (fMRI; 3 Tesla) while performing a forethought task. The task consisted of presentations of 56 original cartoon stories; half represented congruent sequence of action and the other half were incongruent. Participants had to answer if "yes" or "no" the sequences of actions make sense according to their expectation. All stories were presented in block of seven stories in a randomized manner. Non parametric statistical tests as well as independent sample *t*-tests and repeated measures ANOVAs were performed to assess differences between groups on correct answers and reaction time on the behavioural data. The fMRI data were analyzed with SPM5. Head movements were added as covariates into the model. One sample t-tests were then used to compare incongruent and congruent conditions within each group. Two samples t-tests were used for group comparisons.

Results: The behavioral data analysis showed that the mean performances of the ADHD group were consistently below those of the TD group. Adolescents with ADHD were less accurate on the correct answers for both task's conditions and they made more omissions for the incoherent condition compared to adolescents with TD. Moreover, in all conditions, adolescents with ADHD were slower to respond than adolescents with TD. The fMRI data analysis revealed significant activations during performance of the incongruent relative to congruent condition in the left middle orbito-frontal cortex, the right superior and inferior frontal gyri, right frontal inferior operculum, as well as the left supplementary motor area in the group of adolescents with TD. The opposite contrast did not reveal any significant results. In comparison, in the group of adolescents with ADHD, results showed significant activations during performance of the

incongruent versus congruent condition only in the right inferior frontal gyrus (IFG) and the right portion of the basal ganglia (globus pallidus), as well as relative deactivations in the superior frontal cortex for the opposite contrast. The direct comparisons between the diagnostic groups during the incongruent versus congruent contrast, revealed significantly greater activations in the bilateral PFC in the TD adolescents, and more activations in the cerebellar vermis in the adolescents with ADHD (Figure 1 in red and green respectively).

Conclusion: The above results confirm difficulty for adolescents with ADHD to accomplish a task demanding executive functioning such as forethought. The adolescents with ADHD were less accurate and slower than adolescents with TD at forethought. Moreover, these findings are consistent with studies of executive functions and inhibition, which found the involvement of the frontostriatal network in the pathophysiology of ADHD (Bush et al., 2005, Paul et al., 2009). They confirm the role of the PFC in cognitive control and in the ability to orchestrate thought and action and confirm its dysfunction in ADHD. The inverse pattern of activation of the PFC and the cerebellar vermis in the TD and ADHD group could reflect a compensatory role played by the cerebellum in ADHD or be an indication of the malfunction of the neural network between the two regions in ADHD. Further research of the neural correlates of forethought in ADHD is warranted.

References

- Barkley RA 1997. Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. Psychological Bulletin, 121, 65-94.
- Barkley RA 2011. Attention-Deficit\Hyperactivity Disorder, Self-regulation, and Executive Functioning. In: Vohs KD, Roy F Baumesiter, editors. *Hankbook of Self-regulation: Research, Theory, and Applications.* New York: Guilford Press, 551-564.
- Bush G., Valera EM., & Seidman L.J. 2005. Functional neuroimaging of Attention-deficit/hyperactivity disorder: A review and suggested future directions. Biological psychiatry, 57, 1273-1284.
- Paul R., Grieve S.M., Chaudary B., Gordon N., Lawrence J., Cooper N., et al. 2009. Relative contributions of the cerebellar vermis and prefrontal lobe volumes on cognitive function across the adult lifespan. » Neurobiological Aging, 30, 3, 457-465.

Figures

Figure 1: Difference map of results for the TD and the ADHD for the forethought task. Analyses revealed increased brain activations network, predominantly in the frontal regions for the TD relative to ADHD (red). Patients with ADHD showed more localized increased cerebral activation in the cerebellum compared to the TD (green).