Smoking and the developing brain: Altered white matter microstructure in attention-deficit/hyperactivity disorder and healthy controls

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Abstract

Brain white matter (WM) tracts, playing a vital role in the communication between brain regions, undergo important maturational changes during adolescence and young adulthood, a critical period for the development of nicotine dependence. Attention-deficit/hyperactivity disorder (ADHD) is associated with increased smoking and widespread WM abnormalities, suggesting that the developing ADHD brain might be especially vulnerable to effects of smoking. This study aims to investigate the effect of smoking on (WM) microstructure in adolescents and young adults with and without ADHD. Diffusion tensor imaging was performed in an extensively phenotyped sample of nonsmokers (n = 95, 50.5% ADHD), irregular smokers (n = 41, 58.5% ADHD), and regular smokers (n = 50, 82.5% ADHD), aged 14–24 years. A whole-brain voxelwise approach investigated associations of smoking, ADHD and their interaction, with WM microstructure as measured by fractional anisotropy (FA) and mean diffusivity (MD). Widespread alterations in FA and MD were found for regular smokers compared to irregular and nonsmokers, mainly located in the corpus callosum and WM tracts surrounding the basal ganglia. Several regions overlapped with regions of altered FA for ADHD versus controls, albeit in different directions. Irregular and nonsmokers did not differ, and ADHD and smoking did not interact. Results implicate that smoking and ADHD have independent effects on WM microstructure, and possibly do not share underlying mechanisms. Two mechanisms may play a role in the current results. First, smoking may cause alterations in WM microstructure in the maturing brain. Second, pre-existing WM microstructure differences possibly reflect a risk factor for development of a smoking addiction.