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## Improving antisaccade performance in adolescents with attention-deficit/hyperactivity disorder (ADHD)

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**Abstract** The goal of the study was to examine the effects of task manipulations on antisaccade accuracy and response times (RTs) of adolescents with attention-deficit/hyperactivity disorder (ADHD), age-matched controls, 10-year-olds and young adults. Order effects were tested by administering the task at the beginning and end of the session. Other manipulations involved a visual landmark to reduce demands on working memory and internal generation of saccades; spatially specific and non-specific cues at three intervals; and central engagement of attention through perceptual and cognitive means at three intervals. As expected, adolescents with ADHD were impaired relative to age-matched controls in terms of accuracy and saccadic RT on the first administration of the task. Although their accuracy improved with most of the manipulations, it did not improve disproportionately compared to age-matched controls. Nevertheless, with most of the manipulations, they could achieve the same level of accuracy as unaided controls on the first administration of the task. In contrast, the saccadic RTs of the ADHD group came close to normal under several conditions, indicating that elevated antisaccade RTs in this disorder may be related to attentional factors. The ADHD group made more premature saccades and fewer corrective saccades than both the age-matched and younger groups, suggesting difficulties with impulsivity and goal neglect. The findings suggest that cognitive scaffolds can ameliorate at least some of the inhibition deficits in adolescents with ADHD.

**Keywords** Antisaccades · Attention · Attention-deficit/hyperactivity disorder · Inhibition · Development

### Introduction

Inhibition is one of the most prominent cognitive domains affected in attention-deficit/hyperactivity disorder (ADHD) (e.g., Barkley 1997; Lijffijt et al. 2005; Nigg 2001; Sergeant et al. 2002). Yet, despite the abundance of studies demonstrating inhibition deficits in ADHD, there are few studies on non-pharmacological interventions targeted at alleviating the deficits. The goal of this study was to use a simple inhibition task, the antisaccade task, to test if certain experimental manipulations would ameliorate deficits in 12–18-year-olds with ADHD. As inhibitory skills develop during adolescence, the effects of these manipulations were compared across 10-year-olds, adolescents and young adults to place the ADHD data in a developmental context.

On the antisaccade task, participants are presented with a visual stimulus on one side of a computer screen. They are instructed to look away from it to a blank location equidistant from the center but on the opposite side. Performance on this task is compared to that on the prosaccade task, where participants are instructed to look at the target. Typical saccadic response times (RTs) are 150–250 ms on the prosaccade task, and longer by 100–200 ms on the antisaccade task (Hallett and Adams 1980). Error rates are variable, and even healthy adults make many errors depending on the task parameters. The vast majority of these errors are corrected (e.g., Smyrnis et al. 2002), although not necessarily recognized (Mokler and Fischer 1999; Nieuwenhuis et al. 2001).

The cognitive processes involved in the antisaccade task likely include the following (not necessarily in sequential order): keeping task instructions in mind, maintaining preparedness to respond, detecting the target, inhibiting the automatic saccade and refraining from prematurely disengaging visual–spatial attention from fixation, moving attention covertly to the opposite side, computing the transformed sensorimotor coordinates for the internally generated antisaccade and executing the antisaccade (e.g., Amador et al. 1998; Everling and Fischer 1999; Krappman 1998; Olk and Kingstone

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