



“Turning down the heat”: Is poor performance of children with ADHD on tasks tapping “hot” emotional regulation caused by deficits in “cool” executive functions?



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ABSTRACT

Emotional dysregulation in daily life is very common in children with attention deficit hyperactivity disorder (ADHD). It is however not clear whether this reflects a specific deficit or that it may be the result of generic executive function (EF) deficits. The current study addresses this question by means of an emotional working memory (WM) task with 2 memory load conditions and four possible backgrounds (blank screen, neutral, positive or negative picture), which was administered to 38 typically developing children and 29 children with ADHD. Children responded slower on trials when negative pictures were presented at the background versus when neutral pictures were presented, indicating an emotional interference effect; however crucially, groups did not differ in this respect. Reaction times were also slower on trials with a neutral picture as background versus trials without a picture, with children with ADHD showing an enhanced interference effect. There was a main effect of WM load on performance, but it did not interact with interference or group effects. To summarize, the findings indicate a generic interference control deficit in the children with ADHD in the current sample, while they could not provide support for an emotional interference deficit.

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What this paper adds

This paper adds to the existing literature on emotion regulation in children with ADHD by addressing the question whether emotional dysregulation in ADHD reflects a specific deficit or whether it may be understood as an integral part of impaired executive functioning. An emotional n-back task with different backgrounds was applied to distinguish between emotional interference and generic interference effects. The findings could not provide support for a specific emotional interference deficit. Rather, a generic interference control deficit was found, which may have important theoretical and clinical implications.

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1. Introduction

Attention deficit hyperactivity disorder (ADHD) is a very common neurodevelopmental disorder with a childhood onset, which often persists into adulthood (Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007; Willcutt, 2012). According to the Diagnostic and Statistical Manual of Mental Disorders 5 (DSM-5), ADHD is characterized by symptoms of inattention and/or hyperactivity and impulsivity (American Psychiatric Association, 2013). Although no longer diagnostic, impaired emotion regulation is common amongst individuals with ADHD throughout the lifespan (Shaw, Stringaris, Nigg, & Leibenluft, 2014) – and believed to be an important element in functional impairment in daily life (e.g., Anastopoulos et al., 2011). Recently, there is a renewed interest in emotion regulation in ADHD. In their review, Shaw et al. (2014) defined emotional dysregulation as excessive and inappropriate emotional reactions with regard to social norms; emotional lability characterized by rapid mood shifts; and disrupted allocation of attention to emotional stimuli. They concluded that some form of emotional dysregulation is present in 25–45% of children and 30–70% of adults with ADHD. Evidence for these prevalence rates was found in epidemiological studies based on self- and parent-reports, and studies investigating reactive aggression as a reflection of emotional dysregulation (Shaw et al., 2014). Emotional lability, which is characterized for instance by irritability, hot temper and sudden mood shifts, is often linked with ADHD (e.g., Skirrow et al., 2014; Sobanski et al., 2010). In addition to epidemiological studies, studies using frustration-inducing tasks to provoke emotional dysregulation have demonstrated that children with ADHD are characterized by less effective emotion regulation (less use of accommodation and more use of negative responses) and more intense emotional expression than typically developing children (e.g., Maedgen & Carlson, 2000; Melnick & Hinshaw, 2000; Walcott & Landau, 2004).

The presence of emotional dysregulation in ADHD has been linked to dysregulation of underlying neuropsychological processes such as executive functions (EFs) (Barkley, 1997). In domains such as response inhibition and working memory (WM), EF deficits have been identified in ADHD (Lijffijt, Kenemans, Verbaten, & van Engeland, 2005; Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). In daily life however cognitive control often has to be applied in situations when individuals have to process affectively charged stimuli in an emotionally salient environment. In this sense emotion regulation is likely to be underpinned by broader aspects of self-regulation and executive control (Rothbart & Bates, 2006). As a result, emotion regulation has been broadly defined as: “the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one’s goals” (Thompson, 1994, pp. 27–28). EFs are therefore likely to be important for effective emotion regulation (Ochsner & Gross, 2007) as they provide goal maintenance and inhibition of irrelevant (emotional) distractors. Nevertheless, debate continues with regard to whether emotion regulation is an integral part of EF or has an influence beyond EF as well as on how functions in these two domains are interrelated in ADHD. The key question appears to be: Is emotional dysregulation in ADHD the result of generic EF deficits (so called *cool EF*) or has it a distinctive emotional component that is specifically impaired in the disorder (so called *hot EF*)? Interestingly, recent evidence suggests that there is only a partial overlap between emotion regulation problems and EF deficits in predicting ADHD, as emotion regulation independently contributed to the distinction between children with ADHD and typically developing children (Banaschewski et al., 2012; Berlin, Bohlin, Nyberg, & Janols, 2004; Sjöwall, Roth, Lindqvist, & Thorell, 2013).

Recently, researchers have started to study emotion regulation by using EF tasks that include an emotional dimension. However, so far only a few studies have applied emotional EF tasks in ADHD, and although results in general confirm disrupted emotion regulation, findings across studies are not fully consistent. Köchel, Leutgeb, and Schienle (2014) used an emotional go/no-go task and found an impairment to inhibit responses toward angry faces in children with ADHD compared to healthy controls. In another study, a digit categorization task was used with emotional and neutral pictures in the background. Boys with ADHD were found to be slower when confronted with emotional distractors compared to neutral distractors, whereas typically developing controls showed no such effect (López-Martín, Albert, Fernández-Jaén, & Carretié, 2013). A study by Posner et al. (2011) reported a greater interference effect for error rates in adolescents with ADHD compared to typically developing controls when negative words were presented in an emotional stroop task. In addition, the adolescents with ADHD also experienced a greater cognitive distraction. In contrast, no differences in emotional interference between children with ADHD and typically developing children were observed by Passarotti, Sweeney and Pavuluri, who applied a WM task (n-back) with emotional faces (2010b), and an emotional stroop task in another study (2010a). The, to our knowledge, only study on adults reported that subjects with ADHD exhibited lower rates of accuracy in a n-back task compared to control subjects, indicating enhanced distractibility by emotionally salient stimuli (Marx et al., 2011). Finally, the study of Passarotti et al. (2010a) found ADHD-related reduced activity in the ventrolateral prefrontal cortex despite the lack of differences in behavioral performance, which may indicate the use of compensatory strategies.

In the current study, an emotional n-back task was used to study emotion regulation in children with ADHD (Ladouceur et al., 2005). Participants had to perform a non-emotional WM task while irrelevant emotional information appeared in the background. Participants with weakened abilities in regulating their responses to ignore the emotional information were expected to produce slowed reaction times or lower accuracy in high emotion conditions. In contrast with previous studies comparing neutral with positive and/or negative stimuli, we included a fourth condition in this task, resulting in four backgrounds: a black screen, a neutral picture, a negative picture and a positive picture. The inclusion of a condition without any background information made it possible to distinguish a general interference deficit (whereby any distracting information affects performance – a situation commonly seen in ADHD) from a specific problem of emotional interference (whereby especially emotionally charged stimuli affect performance). More specifically, it was predicted that if children

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