

# What Do Meta-Analyses Have to Say About the Efficacy of Neurofeedback Applied to Children With ADHD? Review of Previous Meta-Analyses and a New Meta-Analysis

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## Abstract

**Objective:** We reviewed previously published meta-analyses of neurofeedback applied to children with ADHD and conducted a new meta-analysis of randomized controlled trials (RCTs) that updates previous results and incorporates methodological modifications. **Method:** Searches were carried out through PubMed, Sage, PsycINFO, SpringerLink, and Psycodoc. We used Hedges' (adjusted)  $g$  and a random-effects model. To assess heterogeneity,  $Q$  and  $I^2$  were calculated. We performed different analyses depending on the control groups, ADHD symptoms, pre- and/or posttreatment data used and symptom evaluator. **Results:** We reviewed seven meta-analyses, and 17 studies were incorporated into the meta-analysis. RCTs support the efficacy of neurofeedback applied to ADHD when most proximal evaluators assess symptoms. Neurofeedback significantly improves inattention symptoms when possibly blinded evaluators assess symptoms. The preliminary results suggest that stimulant medication is more effective than neurofeedback. **Conclusion:** New RCTs that establish links between ADHD symptom measurements, subjects' learning after neurofeedback, and neurophysiological measures could improve the quality of the conclusions. (*J. of Att. Dis.* XXXX; XX(X) XX-XX)

## Keywords

ADHD, neurofeedback, meta-analysis, efficacy

## Introduction

ADHD involves problematic behaviors in the areas of inattention and/or hyperactivity-impulsivity. These behaviors are persistent over time and can interfere with the normal functioning or development of the affected person. Three ADHD subtypes have been described according to the predominance of problematic behaviors: combined subtype, predominance of inattention symptoms, and predominance of hyperactivity-impulsivity symptoms (American Psychiatric Association [APA], 2014).

The etiology of ADHD is currently unclear, and more research is needed. Some of the most important etiological factors that may increase the probability of the occurrence of this disorder could be the following: environmental conditions (Froehlich et al., 2011; Sciberras, Mulraney, Silva, & Coghill, 2017), inherited factors (Akutagawa-Martins, Rohde, & Hutz, 2016; Schachar, 2014), and neurobiological characteristics. There is a high volume of research on the specific neurobiological characteristics of people with ADHD (APA, 2014; Gallo & Posner, 2016; Sharma & Couture, 2014).

Pharmacological treatment and behavioral therapy are the most recommended and often applied treatments in children (American Academy of Pediatrics [AAP], 2011; Canadian Attention Deficit Hyperactivity Disorder Resource Alliance [CADDRA], 2011; National Institute for Health and Care Excellence [NICE], 2018; Spanish Ministry of Health, Social Policy, and Equality [MSSSI], 2017). Research suggests the efficacy of these therapies for the treatment of core ADHD symptoms (Cerrillo-Urbina et al., 2018; Cortese et al., 2018; Fabiano et al., 2009) but have limitations.

Stimulant drugs are the most widely used and studied pharmacological treatments. Methylphenidate is the first-choice stimulant drug for children (Cortese et al., 2018). Nonstimulant drugs (e.g., atomoxetine) are also used but have been shown

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