

## Executive function deficits in neurodevelopmental disorders

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### Abstract

Neurodevelopmental Disorders (NDD) including autism/Asperger's (ASD) and Attention Deficit Hyperactivity Disorder (ADHD) has deficits described either in social communication/interaction/ imagination or in attention/concentration/ hyperactivity/impulsivity. There is significant co morbidity, from 30% to 50%. These are often associated with Executive Function Deficits (EFD). EFD is a term used to describe cognitive processes that help individual regulate, control and manage outthoughts and actions. It includes planning, working memory, attention, problem solving, verbal reasoning, inhibition, cognitive flexibility, initiation of actions and monitoring of actions. Though the EFD are not a part of diagnostic criteria, it is these deficits that cause the most morbidity in day-to-day living. The lack of behavior flexibility, emotional control and self-monitoring is the basis of presentation in people seen with the diagnosis of autism/asperger. Environment adaptations advised for ASD of routine, structure and predictability are not focused on supporting the EFDs that a person is struggling with. They do not reduce the morbidity caused in able children/adults with diagnosis of ASD. ADHD presents with difficulties in prioritizing, impulse control, being emotional with mood swings, poor time keeping, poor ability for task initialization, ability to shift attention and organization. Treatment modalities (medications like stimulants and CBT) used in ADHD does not improve EFDs and they require specific adaptations in the environment. Just focusing on core deficits in ASD or ADHD does not enhance the quality of life or the outcomes. Identifying the exact set of EFDs will allow for developing specific adaptations to enhance the quality of life for children, students and adults.

### Introduction:

Executive functions are a set of cognitive abilities that are needed for regulating behavior, including inhibition, working memory, and planning. The ability to regulate behavior is important, as executive functioning has a substantial impact on short-term and long-term life outcomes such as physical and mental health, performance in school, and socioeconomic status. Executive functioning is often impaired in psychiatric disorders, including neurodevelopmental disorders, such as autism spectrum disorder and attention-deficit/hyperactivity disorder. So far, little is known about early executive functioning problems in young children with subclinical traits of ASD and ADHD.

Autism spectrum disorder is characterized by deficits in social interaction and communication, and restricted behavior and interests, whereas the main symptoms in ADHD are inattention and hyperactivity/impulsivity. The prevalence of these disorders among children under 18 years are approximately 1% and 3–5%, respectively. Children with ASD and ADHD can have lower educational achievements and poorer social outcomes, with problems often extending into adulthood. Importantly, traits of ASD and ADHD occur along a continuum of severity, ranging from sub-clinical to severely impaired. However, children

with lower levels of ASD and ADHD traits, not sufficient for a diagnosis, are also suffering from daily impairments.

Executive functioning deficits associated with both ASD and ADHD are found consistently throughout the literature. The main domains in children with ASD comprise shifting, planning, and working memory, although broader executive functioning deficits across all domains have been observed as well. Conversely, children with ADHD have more pronounced difficulties in executive functioning, in the domains of inhibition, working memory, vigilance, and planning. These difficulties are not only seen among those with a clinical diagnosis, as few population-based studies suggest that children and adults with subclinical traits of ASD or ADHD also experience problems in executive functioning. These findings are important, as children with subclinical traits of disorders often remain undetected by mental health services for various reasons, including symptoms not being severe enough to warrant help seeking, stigmatization of seeking help for mental problems, and inability to pay. However, sub-clinical symptoms may be associated with other sub-clinical characteristics, such as cognition function, which may result in some impairment. Indeed, executive functioning has a substantial impact on short-term and long-term life outcomes.

Only a minority of studies in this field has focused on young children with neurodevelopmental traits. Young children with ADHD or at high risk for ADHD appear to be impaired in executive functioning, while research on young children with ASD is more inconclusive. Some studies find no differences in executive functioning between children with and without ASD, whereas others do, but depending on the different age or means of measuring executive functioning. It has been argued that performance tasks and behavioral ratings should be distinguished from each other, as they may measure different aspects of executive functioning. Performance tasks are more situational and measure abilities in a specific environment, whereas behavioral ratings focus on the ability to apply these skills in daily life, perhaps making the latter more generalizable and therefore clinically more relevant.

### **Conclusion:**

The main aim of our study was to examine the specific neuropsychological profiles of children with a clinical diagnosis of either ADHD or SLD—with major impairment in both reading and math, or both in comorbidity (ADHD + SLD), by comparison with TD children. We were particularly interested in understanding whether the EFs profiles of four groups differed and whether the comorbid group (ADHD + SLD) showed an additive (i.e., the sum of the deficits in the isolated groups) or rather an interactive effect (i.e., a distinct deficit profile). Children in the clinical groups had been previously diagnosed at centers specialized in neurodevelopmental disorders. In the first part of the assessment, all their diagnoses had been confirmed through specific questionnaires for parents and appropriate academic achievement tests.

To test potential differences in EFs profiles, children with a clinical diagnosis of ADHD, SLD, and comorbid ADHD + SLD were compared with TD children on measures of inhibition, shifting, and updating. In our analyses, we first compared our groups considering EF measures separately. Then, we ran the same analyses considering the presence of ADHD (no/yes) and/or SLD (no/yes) as factors to see whether the comorbid group reveals an additive profile. Finally, mixed-effects models were used to analyze in detail performances at different span levels for the updating tasks.

In the group comparisons, our findings showed that all clinical groups performed worse than the TD group, and no differences emerged between any of the clinical groups on measures of inhibition and shifting. A more specific pattern emerged when the groups were compared on updating measures. Children with SLD performed less well than the other groups in the verbal task, while the groups with ADHD or ADHD + SLD performed less well than either the SLD or the TD groups in the visuospatial

task. This would contradict the idea of an additive effect of the two disorders combined. The pattern was slightly different when we considered the presence or absence of symptoms of SLD or ADHD: the effects of both SLD and ADHD could be seen in the inhibition task, but only those of ADHD in the shifting task. The effect of SLD was apparent for verbal updating and that of ADHD for visuospatial updating. Notably, from a qualitative perspective, children with ADHD + SLD were not more severely impaired than those with either ADHD or SLD alone. This would contradict the interactive hypothesis that children with several problems in comorbidity exhibit a qualitatively distinct condition. Finally, by considering group performances at different span levels, a specific pattern emerged in the visuospatial updating task. Children with ADHD performed significantly worse on Span level 3 then showed a slight improvement on level 4, whereas the other groups had a more linear worsening performance with longer spans. Our results can be explained by altered motivational processes in ADHD, or the children's inability to regulate their state of activation.

The novelty of our investigation lies in that we compared these clinical groups with one another, as well as with a TD group, as previously reported. The results underlined that EFs are similarly compromised in all clinical groups, pointing to a comorbidity explanation based on a domain-general cognitive level. In particular, EF impairments, are not enough to differentiate between ADHD and SLD, shedding further light on the importance of comparisons across disorders and studies on comorbid conditions. Although ADHD is often associated with EF deficits, this association did not seem sufficient to consider EF as core-deficits of the disorder, and impairments in inhibition and shifting have also been observed in children with SLD.