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REVIEW ARTICLE

# Executive functions in children with autism spectrum disorder

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**Abstract**

Executive functions (EFs) are cognitive processes that regulate a person's behaviour and ability to react to their environment flexibly and efficiently. In this review, we focus on three essential EFs: inhibitory control, working memory and cognitive flexibility, and their connections to the impairments observed in autism spectrum disorders. Autism spectrum disorders (ASD) are neurodevelopmental conditions characterized by deficits in social interaction and communication, restricted and repetitive behaviours, and interests. Evidence suggests that impaired EFs are not a primary deficit resulting in the ASD core symptoms, still, they affect the ASD behavioural presentation. Executive dysfunction can have adverse effects on the development of the adaptive behaviour of children with ASD. Children with ASD have more problems with inflexibility, which is predictive of comorbid anxiety and depression. Although, the scientific evidence revealed that executive dysfunction is associated with many issues encountered by individuals with ASD, there are still many inconsistencies and gaps in knowledge that need to be addressed in future studies. This review accentuates the significance of EFs for everyday functioning of individuals with ASD. It points at a need for early interventions that may assist the ASD individuals to improve their executive functions, social functioning and consequently, having beneficial effect on the quality of their life.

## Introduction

Executive functions (EFs) are defined as higher order cognitive processes that affect an individual's ability to solve problems flexibly and efficiently and to react to their environment (Benallie *et al.* 2021). EFs are generally important for coordinating and regulating a variety of psychological manifestations. They enable control of human behaviour, self-regulation, and resistance to distractors and/or tempting stimuli (Vágnerová 2020). Overall, executive processes enable effective use of mental and physical human capacities in unknown or less structured situations (Procházka *et al.* 2021).

EFs are involved to a varying degree not only in solving novel tasks but also in everyday situations.

In familiar situations, regulation takes place automatically through proven and comprehensive schemes. In contrast, for non-standard situations a higher level of activation of some components of the EFs is required, e.g. planning and conscious control (Stuss & Alexander 2000).

While some authors classify EFs as higher cognitive functions, other theoretical models understand EFs as independent processes that operate alongside the cognition and affectivity and together they form the behavioural side of human existence (Lezak *et al.* 2012). EFs are essential for learning, academic achievement (Best *et al.* 2011), and emotional regulation (Ferrier *et al.* 2014). Additionally, according to Moffitt *et al.* (2011) the level of inhibition, being one of the EFs, can predict physical health, substance dependence, personal finances, and criminal offending outcomes. This may present a problem in individuals with neurodevelopmental disorders, including autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), or schizophrenia (Hill 2004).

## Classification of EFs

There is a relatively large number of theoretical perspectives on what EFs are and what processes they include. One of the original classifications of EFs was made by Lurija (1982) who at the time spoke of anticipation, planning, management, and self-monitoring. Johnstone and Stonnington (2009) cite initiation (start-up processes), termination (processes related to the cessation of activities), and self-regulation (processes related to self-control and self-awareness) as the main components of EFs. For the purpose of this review, we adapted the classification by Diamond (2013) who proposed the following EFs: inhibition (resisting temptations and impulsive actions), working memory (holding information in mind and working with it), and cognitive flexibility (changing perspective spatially or interpersonally). A more detailed characteristic of these EFs is presented in next sections of this article. From these three functions, the higher order executive functions such as reasoning, problem solving, and planning are built.

## Anatomical substrates of EFs

Early studies of patients with frontal lobe damage reported difficulties in reasoning, planning, problem-solving, and decision-making (Foong *et al.* 1997). This led to a presumption that EFs are largely associated with functions of the frontal lobe (Glosser & Goodglass 1990). Although, there is a large amount of evidence that frontal lobe patients demonstrate deficits in EFs (e.g., Harlow 1993), several studies found frontal lesion patients with no significant impairments in their executive functioning (Anderson *et al.* 1995), suggesting that frontal lesions do not necessarily result in executive dysfunction. In fact, recent studies (Owen *et al.* 2005) have revealed that the frontal cortex is just one element involved in the complex network comprised of cortical structures, subcortical structures, and thalamic pathways that form the anatomical substrates of EFs (Lewis *et al.* 2004). Additionally, parietal areas were found to play a key role in all EF tasks (Collette *et al.* 2006). The findings, however, do not undermine the importance of the frontal lobe in executive functioning. Instead, it is assumed that prefrontal regions rely on the input from other areas and further orchestrate the behaviour (Jurado & Rosseli 2007). Additionally, it appears that the frontal cortex does not mediate EFs in isolation. Instead, increased activity in the parietal regions suggests that frontal and parietal regions together mediate the executive processes.

## Development of executive functions in neurotypical children

EFs evolve throughout the life span and their developmental trajectories vary due to differences in the underlying psychological and neural processes (Thorell *et al.* 2009). They develop in different velocities with phases of fast advancement and relative stagnation. There are different relationships and mutual influences among EFs, more specifically, improving one EF can enhance the development of another (Vágnerová 2020). EFs emerge in early childhood and strengthen significantly throughout late childhood and adolescence (Best & Miller 2010; Espy *et al.* 2001; Lee *et al.* 2013). In standard development, the foundations of EFs are being laid by the age of three years. In younger children, these executive abilities are named the „general executive processes" because they refer to a single undifferentiated skill (Wiebe *et al.* 2008). After the 3$^{rd}$ year of life, qualitative changes occur. After the 4$^{th}$ year, EFs begin to differentiate more into inhibition and working memory (Jurado & Rosselli 2007). At the end of the preschool age, executive functions differentiate into three basic interrelated processes: inhibition, working memory and cognitive flexibility (Isquith *et al.* 2004). Certain level of executive ability is necessary to manage the school obligations, and starting school has been linked to a further differentiation of EFs. Other forms of higher order EFs, including the ability to plan and make decisions, make logical judgments, and solve problems, develop in older children (Ardila 2013). The largest progress in shifting, inhibition, and selective attention was observed between the age of 8 and 10 years with a plateau in performance between 10 and 12 years (Klimkeit *et al.* 2004). While in the preschool years the development of EFs has a quantitative character, it demonstrates more of a qualitative character in later years (Decker *et al.* 2016).

The approach to a problem and the choice of a solution differs depending on age. The approach to a problem solving may depend on a certain executive


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function in a given developmental period, while it may depend on another executive function in the following period of development (Vágnerová 2020).

## Executive functions in autism spectrum disorder

Autism spectrum disorder (ASD) refers to a diverse group of neurodevelopmental conditions characterized by deficits in social interaction and communication, restricted and repetitive behaviours, and interests (Hill 2004), frequently accompanied by sensory impairments and various levels of intellectual disability (Lord *et al.* 2020). The restricted and repetitive behaviours and interests (RRBIs) can be further divided into two categories: insistence on sameness (IS) and repetitive sensory motor (RSM) behaviours (Bishop *et al.* 2013). They are conceptualized as *higher order* RRBIs (e.g. preoccupations/circumscribed interests, compulsive routines and ritualistic behaviour), and *sensorimotor* RRBIs (e.g. stereotyped and repetitive movements and sensory preoccupations) (Faja & Nelson, 2019; Mosconi *et al.* 2009). Core behavioural components of ASD emerge usually within the first two years of life (Estes *et al.* 2015). In addition to the core features, it is quite common that people with ASD are affected by co-occurring psychiatric or neurological disorders such as hyperactivity and attention disorders, anxiety, depression, and epilepsy (Lord *et al.* 2020).

The evidence suggests that impaired EFs are not a primary deficit resulting in the presentation of autism symptoms (Yerys *et al.* 2007), still, they do affect the ASD behavioural presentation (Kenworthy *et al.* 2009). Problems in EFs can serve as predictors of the severity of the ASD core symptoms including repetitive behaviour (Sadeghi *et al.* 2021), or deficits in social communication (Zilberfayn 2019). Additionally, Lawson *et al.* (2015) discovered that children with ASD have more problems with inflexibility, which is predictive of comorbid anxiety and depression, as the inflexibility contributes to the levels of rumination, depression, and symptoms of anxiety. Executive dysfunction can also adversely affect the development of the adaptive behaviour of children with ASD (Pellicano 2012), thus their social functioning in everyday circumstances (Torske *et al.* 2018) and consequently, the quality of their life (de Vries & Geurts 2015).

Evidence suggests that individuals with ASD present with limited social interaction, they have poor job perspective in adulthood (Howlin & Magiati 2017) and are more likely to develop mental disorders, especially anxiety disorders (Hepburn *et al.* 2014; White *et al.* 2018; Zimmerman *et al.* 2017), and depression (Hofvander *et al.* 2009). Many adults with ASD remain dependent on their families, their work is often poorly paid, and they are not fully self-sufficient (Hofvander *et al.* 2009; Howlin *et al.* 2004). Most of the children with ASD have worse long-term psychosocial outcome (Billstedt *et al.* 2005) even though for some of them, it may be similar to typically developing individuals (Howlin *et al.* 2004).

## Inhibitory control

Inhibitory control involves the ability to suppress contextually inappropriate responses, tendencies to impulsive behaviour or undue attention. Not only it refers to attention and behaviour inhibition, but also to thoughts and memories inhibition (Diamond 2013). Thus, we can differentiate between cognitive and behavioural inhibition. In neurotypical individuals, inhibition reaches adult levels of maturation around the age of 9 or 10 years (Welsh *et al.* 1991). Psychological measures that assess inhibitory control include the Stroop task, Flanker task, antisaccade tasks, go/no-go tasks or stop-signal tasks (Diamond 2013).

Deficits in inhibition-related processes have been postulated in many disorders, such as attention-deficit/hyperactivity disorder (ADHD), schizophrenia and/or obsessive-compulsive disorder (Friedman & Miyake 2004). Inhibition problems are often observed also in individuals with ASD. For example, they may experience difficulties with response inhibition to a phone ringing (i.e. picking up the phone), because they have learned that answering the phone is polite. Other behavioural characteristics of the ASD include the literal interpretation of language as well as the repetitive behaviour. While the literal interpretation refers to the inability to suppress frequently used meanings of words, the repetitive behaviours suggest difficulties to suppress behaviour despite its negative consequences (Geurts *et al.* 2014). Deficits in inhibitory control can be observed already in toddlers aged only 24 months and who are diagnosed with ASD later in life (St. John *et al.* 2016), and they can also be found in relatives of individuals with ASD (Mosconi *et al.* 2010). Difficulties with inhibitory control are also associated with restricted and repetitive behaviours (Mosconi *et al.* 2009). They can indicate neurocognitive impairments that affect patients' ability to limit behaviour that is prepotent but contextually inappropriate (e.g. preoccupation with their special interest and repetitive behaviours). Therefore, a better understanding of inhibitory control deficits can guide our understanding of the core clinical signs of ASD (Schmitt *et al.* 2018).

Inhibitory control is often considered a single construct but in behavioural and cognitive neurosciences inhibition is viewed as of multifaceted nature. Thus, inhibition is divided into prepotent response inhibition, resistance to distractor interference, and resistance to proactive interference (Friedman & Miyake 2004). Individuals with ASD experience difficulties in prepotent response inhibition, i.e. the ability to suppress a previously reinforced behavioural response (Corbett *et al.* 2009), and also in interference control, i.e. the ability to ignore irrelevant information while processing target stimuli (Christ *et al.* 2007). According to a meta-analysis by Geurtz *et al.* (2014), in ASD, the prepotent response inhibition is more severely impaired than the distractor interference. Inhibition of prepotent responses depends on reactive and proactive control mechanisms. Reactive control involves termination of an already initiated behaviour when instructed by a signal, while proactive speaks of stopping or slowing down an upcoming response (Aron 2011). According to research by Schmitt *et al.* (2018) in patients with ASD, the proactive control is impaired, while the reactive one appears to be preserved. In addition, they found that more severe deficits in inhibitory control were associated with more severe RRBIs. Furthermore, the inhibitory control impairments also become more severe in adolescence and adulthood, as typical age-related improvements in inhibition are attenuated. This accentuates an important developmental window during which treatments may reduce cognitive changes that contribute to repetitive behaviours (Schmitt *et al.* 2018).

Interference control that suppresses interfering stimuli that cue a repetitive behaviour, interest or desire for sameness is also important for predicting whether a child with ASD engages in higher order RRBIs (Faja & Nelson 2019). For example, in new or unexpected situations, individuals with ASD may engage in more compulsive or ritualistic behaviour because of their reduced ability to proactively withhold the contextually inappropriate behaviours (Schmitt *et al.* 2018). Individuals with ASD prefer predictable environment, where they can take more control. Social encounters are naturally difficult to control while insistence on sameness and restricted interests are reported to be pleasurable; and therefore they have rewarding effects for people with ASD (Kohls *et al.* 2014). It is possible that RRBIs reflect an intolerance to uncertainty and this may explain why they sometimes manifest more frequently in social situations (Schmitt at al 2018).

Engagement in restricted interests interferes with children's self-directed learning and contributes to interpersonal difficulties that can already begin at preschool age (Klin *et al.* 2007). These behaviours also interfere with family functioning (Lin & Koegel 2018) and they are correlated with increased levels of parental stress (Gabriels *et al.* 2005). Furthermore, children with stronger inhibition abilities show improved early learning skills (Pellicano *et al.* 2017). Additionally, inhibitory control is related to adulthood outcomes. As self-control is an aspect of inhibitory control, the research of Moffitt *et al.* (2011) can shed some light on possible outcomes. They found out that in general, children with poor self-control had elevated risk of physical and mental health problems (e.g. hypertension, overweight or substance abuse), earned less and had more money-management difficulties, they were more likely to be convicted of a criminal offense, while controlling for IQ, gender, social class and family circumstances during growing up. The authors also found that children whose self-control improved from childhood to young adulthood had better outcomes as adults suggesting that early childhood intervention enhancing self-control skills is likely to have positive impact on ASD individuals' life (Moffitt *et al.* 2011).

## Working memory

A core feature of EF is the working memory (WM), that refers to the system responsible for temporary storage and manipulation of information necessary for complex cognitive tasks such as language comprehension, learning, and reasoning (Baddeley & Hitch 1974). The most widely accepted model for WM, proposed by Baddeley and Hitch (refined by Baddeley, 1986; Baddeley, 2000; Salamé & Baddeley, 1982), suggests that WM consists of the central executive component which is considered a control system of a limited attentional capacity and is responsible for two "slave subsystems", namely the phonological loop, and the visuo-spatial sketchpad. While the phonological loop holds verbal-based information, the visuo-spatial sketchpad stores information based on its visual or spatial features. Later, a fourth component named an episodic buffer was added to the model. This component describes a system that combines information from the „slave subsystems" into a multi-faced code and captures the interaction between the short-term and long-term memory. This model will be further examined in relation to ASD, in consideration of individual model components.

The core of the WM model comprises of the central executive, which is concerned with attention control and incoming information processing (Baddeley & Hitch 1974). Although, there are indications of impairments in the central executive in ASD (Cui *et al.* 2010; Joseph *et al.* 2005), the central executive has received little attention within the research. Thus, there is a need for empirical evidence focusing on the relationship between ASD and WM.

In contrast, studies investigating the individual WM components in more depth (i.e., specifically focusing on the visuospatial sketchpad and phonological loop), revealed some inconsistent findings. For example, Ozonoff and Strayer (2001) found no differences in spatial WM between the ASD and control groups, employing tasks with memory load consisting of 1,3, or 5 stimuli. In contrast, Goldberg and colleagues (2005) found a subtle impairment in ASD children when they employed a visual task with a memory load of a 6 to 8 stimuli, suggesting that the differences in visuospatial sketchpad between individuals with ASD and controls might be revealed using higher memory load. To address these inconsistencies within the research, several recent meta-analyses (Habib *et al.* 2019; Lai *et al.* 2017; Wang *et al.* 2017) investigated the visuospatial abilities in ASD individuals in comparison to the controls. These meta-analyses reached an agreement


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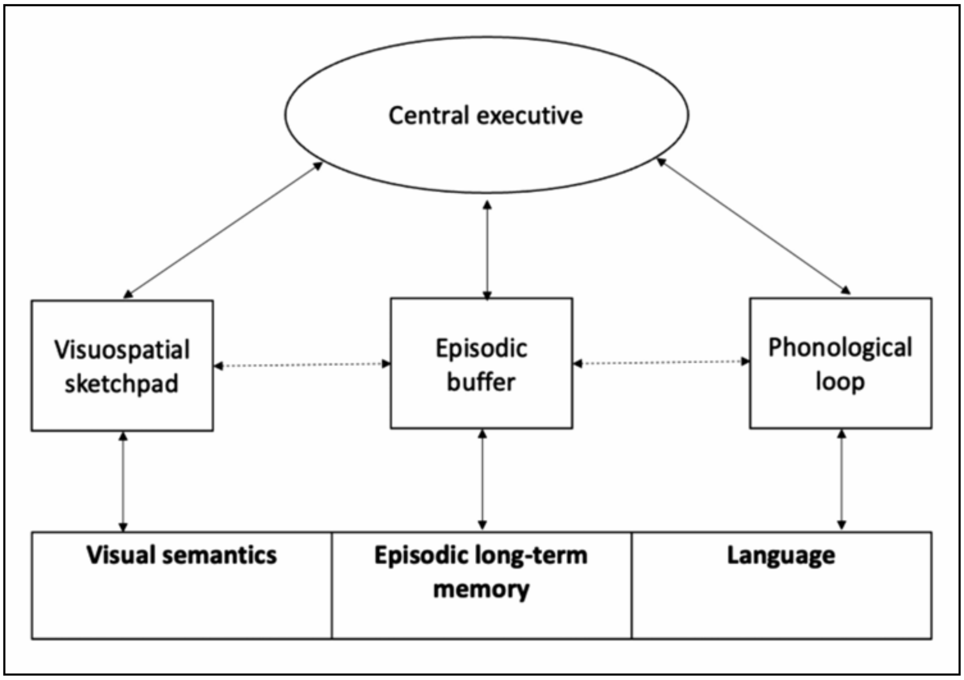


**Fig. 1.** Development of multicomponent working memory (model adapted from Baddeley and Hitch 2000)

suggesting that individuals with ASD demonstrate considerable impairments in visuospatial component of WM across their lifespan. Studies investigating the phonological loop in ASD, revealed similar inconsistencies to those found in research focusing on the visuospatial sketchpad. More specifically, a number of studies found no verbal WM impairments in high functioning autistic individuals (children and adults) compared to the controls (Russell *et al.* 1996; Williams *et al.* 2005). However, Kercood and colleagues (2014) reviewed both studies (Russell *et al.* 1996; Williams *et al.* 2005) and suggested that the results might not reflect the verbal abilities of all autistic individuals because the authors recruited only children with high functioning autism. Thus, the results must be interpreted with caution, especially in the people with more severe forms of ASD. Two meta-analyses (Habib *et al.* 2019; Wang *et al.* 2017) have shown phonological deficits in individuals with ASD. Lai *et al.* (2017) in their meta-analysis revealed the phonological impairments, they also highlighted that more severe impairment was elicited by the Sentence Repetitions tasks and Non-Word Repetition tasks compared to other verbal WM tasks (e.g., digital span tasks or the letter-number sequencing task). The authors stressed that since ASD individuals often experience language impairments (such as syntax, language comprehension and production, and/or phonological skills, pragmatics), the poor performance on these tasks might reflect poor language skills instead of impairments in EFs. Thus, while the phonological deficits might appear evident, they also must be interpreted with caution.

The most recent addition to Baddeley's WM model is the episodic buffer which links the visual and auditory information into the multi-faced code during the episodic memory retrieval (Lind & Bowler 2010). Bowler *et al.* (2008) hypothesised that impairments in the episodic buffer might explain difficulties with complex recall (i.e., combination of items) in contrast to the intact ability to recall a single item in ASD individuals. However, executive buffer was added to the WM model only recently and therefore more empirical evidence is needed to draw any conclusions.

Overall, the research focusing on the relationship between WM and ASD suggested possible deficits in the central executive and episodic buffer. While there are some indications of impairments in the two components in ASD, there is a need for more empirical evidence. Additionally, there seem to be some alterations in the visual spatial sketchpad and phonological loop in ASD. However, research revealed that some tasks focusing on phonological component might reflect impairment in language skills instead of the EFs and therefore must be interpreted with caution.

## Cognitive flexibility

The third core EF is the cognitive flexibility (also referred to as the set shifting or mental flexibility). It enables to change perspectives (spatially or interpersonally), to change how we think about things, adjust to the changed demands or priorities, and to take an advantage of unexpected opportunities. Cognitive flexibility depends on both, inhibitory control and WM, when changing a perspective. First, a person must inhibit their previous perspective and then activate a different perspective with the help of WM (Diamond 2013). Assessing cognitive flexibility requires solving problems when one is required to switch from one objective to another in response to an external cue (Engel de Abreu *et al.* 2014). This is usually assessed by using the Wisconsin Card Sort Test (WCST) as the most widely used test of flexibility skills (Landry & Al-Taie 2016). Deficits in flexibility can be observed in a number of conditions including traumatic brain injury (Pang *et al.* 2016), obsessive-compulsive disorder (Morein-Zamir *et al.* 2016), anxiety (Lawson *et al.* 2015) and eating disorders (Arlt *et al.* 2016), depression (Stange *et al.* 2016) as well as the clinical presentation of ASD. Individuals with ASD have problems with rigidity in behaviour such as difficulties in changing strategy during daily activities or adapting their perspective during social interactions (Geurts *et al.* 2009). Moreover, common problems that include inflexible adherence to specific routines, resistance to change, circumscribed interests and preoccupation with particular objects, or activities may reflect impairments in cognitive flexibility (Leung & Zakzanis 2014).

However, in the scientific literature, we can find inconsistent findings regarding the ASD symptomatology and its relationship to cognitive inflexibility. Happé *et al.* (2006) failed to find any differences in cognitive flexibility between children with ASD and healthy controls. Yet, other studies suggested that individuals with ASD demonstrate greater difficulties in cognitive flexibility and planning compared to the control groups (Geurts *et al.* 2004; Yerys *et al.* 2009). Furthermore, Yerys *et al.* (2009) revealed a correlation between errors in set-shifting tasks and restricted and repetitive behaviour symptoms in the ASD group. The observed inconsistencies in the earlier research studies may be related to the way in which cognitive flexibility has been measured. Specifically, the EFs can be evaluated with laboratory-based neurocognitive tasks or behavioural self-reports (Albein-Urios *et al.* 2018). Laboratory-based tasks include the WCST (Grant & Berg 1948), the Intradimensional-Extradimensional Shift task (ID/ED; Owen *et al.* 1991) and the Trail Making Test (Swanson 2005), while the Behaviour Rating Inventory of Executive Function (BRIEF) is the most commonly used tool that evaluates everyday life behaviours that emerge from impairments in EFs, including cognitive flexibility (Albein-Urios *et al.* 2018). It is important to note that the predictive value for everyday functioning of the laboratory-based tasks can be impeded because of their limited ecological validity (Burgess *et al.* 2006) while the BRIEF is considered ecologically valid and also addresses the „real life“ demands (Kenworthy *et al.* 2008). The inconsistencies in the scientific evidence can also be explained by the inter-individual variability in age, clinical severity, IQ, and psychiatric and neurological comorbidities (Albein-Urios *et al.* 2018).

In their research, Faja & Nelson (2019) discovered that reduced inhibitory control and flexibility were related to preoccupations/circumscribed interests, compulsive routines, and ritualistic behaviour (i.e., the higher order RRBIs) in children with ASD. The authors suggest that the ability to flexibly shift and suppress interfering information are protective against higher order RRBIs symptoms in autism and highlight the importance of distinguishing between higher order and sensorimotor symptoms because of their apparent relation to EFs. Flexibility has also been associated with reading ability (Engel de Abreu *et al.* 2014) and other outcomes in adulthood. For example, Genet *et al.* (2013) discovered in their research that cognitive flexibility is also a good predictor of trait resilience in adults, which is a stable personality characteristic that involves the ability to flexibly adapt to emotional events and situations. Flexibility is also related to and predictive of adaptive behaviour in ASD (Pugliese *et al.* 2015). Finally, improving flexibility and planning skills in children with ASD have ameliorated their social skills and improved their ability to follow rules, make transitions and be more flexible (Kenworthy *et al.* 2014).

## Conclusion

EFs refer to a series of processes that regulate actions through thoughts. Although there is no general agreement on the processes that the EFs include, in this review, we summarized existing literature focusing on the 3 EFs components (inhibition, working memory, and cognitive flexibility) that were proposed by Diamond (2013). The EFs research focusing on anatomical structures underlying the EFs revealed that they rely on a rather complicated network consisting of cortical, subcortical, and thalamic pathways. Additionally, the research has shown that both parietal and frontal regions together mediate the EFs. This suggests that the development of EFs relies on complex networks regulated by a number of brain regions. Thus, the development of these regions can either facilitate the optimal brain function or it can interfere with it in case of impaired development. With regard to the EF development, the evidence suggests that EFs in typically developing children are undifferentiated by the age of 3 years, the core EF components (working memory, inhibition, and cognitive flexibility) develop by preschool age, and fully differentiate by the age of 6 years. In contrast, children with ASD often demonstrate atypical behaviours linked to executive deficits already by the age of 2 years.

While clear indications of inhibition deficits were found in individuals with ASD, there were some inconsistencies within the research with regards to the WM



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and cognitive flexibility. For WM, there is a need for more empirical evidence to establish a link between the central executive, the episodic buffer, and ASD. However, the research suggests that there are deficits in the phonological loop and the visuospatial sketchpad in ASD. Furthermore, the inconsistencies in evidence aimed at the cognitive flexibility in the context of ASD, may be attributed to the variations in the assessment tools. It is clear that more empirical evidence is necessary to shed light on the lack of agreement on the link between ASD and EFs, however, some evident deficits in ASD have been emphasized.

The impairment in executive functioning is characterized by as much heterogeneity as is observed in the autism spectrum disorder presentation. The heterogeneity of ASD can also explain the inconsistent results within the EFs research, as it can depend on whether only children with high-functioning ASD were included in the research samples or if children with a high degree of disability were also evaluated. These differences may be potentially used as a marker and facilitate classification of ASD into subtypes that could improve diagnostic process, and subsequently also the interventions (Demetriou *et al.* 2019). There may also be differences in EFs between males and females but the research is still limited and with no clear conclusion: some studies report no differences while others suggest that the executive functioning may differ (Demetriou *et al.* 2019). A question if females with high-functioning ASD do experience deficits in EFs or they are just very well compensated also contributes to this uncertainty. Although, the deficits in executive abilities are evident in ASD, an early intervention was found to assist ASD individuals with improving their executive functions (Diamond 2013), social functioning and consequently, it was found to improve their quality of life (de Vries & Geurts 2015).

The three core EFs (inhibition, working memory, and cognitive flexibility) are being investigated in the context of ASD based on the large amount of previous evidence that associated executive dysfunction with ASD. The literature revealed that executive dysfunction is linked with a reduced adaptive functioning (Pugliese at al 2015), higher severity of ASD symptoms (Faja & Nelson 2019), and deficits in social communication (Zilberfayn 2019). It needs to be emphasized that in the overall picture of the executive dysfunction in ASD, the connection between the EFs and IQ is also very important. This is a very complex topic that would require a discussion in more depth in a separate article. Overall, this review highlights the importance of EFs in individuals' lives and the severity of executive dysfunction. It is therefore essential to expand the research on this topic, and also to further encourage the parents of ASD individuals to attend early interventions as they were found to have positive impact on EFs, and in general the quality of their lives.

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