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REVIEW ARTICLE

Additional language learning in ADHD: a call for research

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Abstract
The importance of additional language learning (ALL) is on the rise, but we do not yet have a full understanding of how learners with different characteristics approach this task. Here, we discuss the potential impact of attention-deficit/hyperactivity disorder (ADHD), a prevalent learning disability, on classroom ALL. Learners with ADHD show difficulties in the attention networks of sustained attention and executive control. It is critical, therefore, to ask how these difficulties of learners with ADHD might manifest in the demanding task of ALL, but to date there is very limited research examining this issue. The current paper sets out a theoretical framework for examining ALL in learners with ADHD, reviews the extant literature, and most importantly calls for future research to examine the way in which learners with ADHD manage the process of ALL, in an effort to highlight the involvement of sustained attention and executive control in ALL more generally.

Keywords: Additional language learning; ADHD; executive control; foreign language; sustained attention; L2

In most countries, including Europe, Asia, Africa, and the Middle East, schools and universities require students to learn an additional language as a graduation requirement (European Council, 2002). Further, in many higher education systems, parts of the curriculum and/or reading materials are only accessible in an additional language, most commonly English. Despite the widespread importance of additional language learning (ALL)[1], it is not clear that all learners can achieve similar success in this task. Specifically, whether ALL poses challenges for learners with attention-deficit/hyperactivity disorder (ADHD) has been addressed in only a handful of studies (Leons et al., 2009; Marashi & Dolatdoost, 2016; Paling, 2020; Sparks et al., 2004; Turketi, 2010), despite the high global prevalence of ADHD, estimated at around 5% in children (World Health Organization, 2023). Therefore, the empirical evidence necessary for answering this question or for guiding the

development of tailored instructional approaches is not available in the existing literature. This lack of research has left educators and researchers without clear guidance on how best to support this population.

In light of this situation, the current paper aims to make two main contributions. First, it frames an underexplored topic in a way that highlights its significance and urgency for future studies. Second, it serves as a tutorial aimed at bridging this gap. Specifically, the paper is designed for educators, researchers, and practitioners in language-related disciplines who may be less familiar with the cognitive mechanisms underlying ADHD, with the goal of providing a clearer starting point for formulating more specific research questions.

To this end, the current paper provides an overview of the cognitive profiles of learners with ADHD, and how these might map onto the cognitive demands of ALL, in order to identify potential difficulties these learners may encounter and highlight areas where further research is urgently needed. By synthesizing the very limited existing research, this tutorial provides a conceptual framework to motivate further investigation into the underexplored intersection of ADHD and ALL. In doing so, we seek to provide the basis for tailored instruction, making ALL accessible to this population of learners, and allowing them to keep pace with their classmates. Further, studying clinical populations, such as learners with ADHD, can help uncover the cognitive capacities and attentional mechanisms that are implicated in ALL more generally.

Although learning an additional language may take various forms, including online learning, immersion, immigration, or other informal settings, in the current paper we focus on classroom learning of an additional language, in which the language is taught explicitly as a school subject for learners with no immersion experience. Throughout this paper, we have adopted the term "additional language" (which has been used previously, e.g., D'Angelo, 2020; Edmonds et al. 2020, Gudmestad et al., 2019) to promote inclusivity and equality among languages, such that the additional language may reflect a second language, a foreign language, or an L(n). While other terms, including L2 learning or SLA, are more commonly used in the literature, they may be misleading in contexts involving multilingual learners or non-sequential acquisition. We adopt *ALL* to enhance conceptual clarity, particularly in research involving trilingual learners and varied linguistic backgrounds. In the current paper, we ask whether learners with ADHD might incur specific difficulties in the complex task of classroom ALL, which includes acquisition and internalization of various facets of linguistic knowledge, including phonology, vocabulary, grammar, and discourse structures.

As illustrated in Figure 1, the outset of this paper provides an overview of ADHD (purple rectangle in Figure 1), outlining its key characteristics and etiology. These characteristics are then contextualized through the framework of the Attention Systems Model (Posner & Petersen, 1990), with a detailed explanation of each attentional network and a discussion of how ADHD relates to these networks (red lines in Figure 1). Subsequently, we propose how each attentional network might contribute to ALL (dashed blue lines in Figure 1). Based on the limited empirical evidence on ALL and ADHD, we then offer insights regarding the potential challenges learners with ADHD might face in ALL (dashed green line in Figure 1). Acknowledging the limited research in this area, the paper concludes with a "Call

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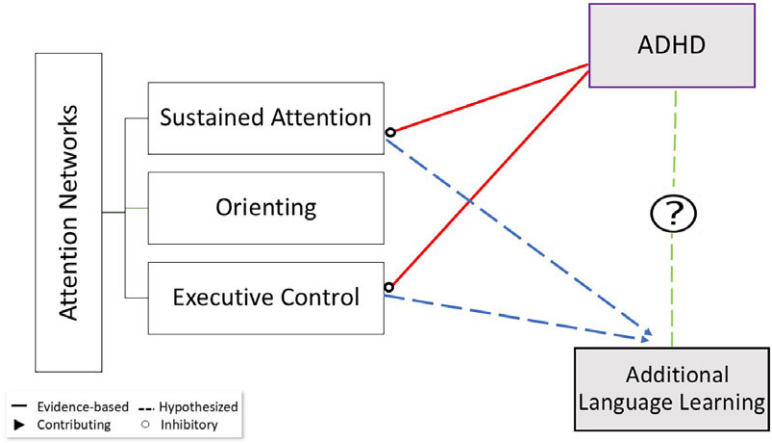

Figure 1. Illustration of the hypothesized associations between attention networks, ADHD, and additional language learning.

for Future Research" section, emphasizing the urgent need for further systematic empirical studies to better understand the experiences of learners with ADHD in ALL.

What is ADHD?

ADHD is a neurodevelopmental disorder characterized by behavioral symptoms of inattention, impulsivity, and hyperactivity (Bush, 2010; Konrad et al., 2006), which can significantly impair daily functioning. Inattention, a core feature of the disorder, reflects broad difficulties in attentional processing, including challenges in directing, sustaining, and shifting attention. For example, individuals might struggle to complete tasks because they are easily distracted by irrelevant stimuli or may appear not to listen when spoken to directly, or frequently make careless mistakes. Impulsivity refers to acting rashly without forethought, such as interrupting conversations, blurting out answers inappropriately, or making hasty decisions without considering the consequences. Hyperactivity is often described as excessive motor activity and restlessness and may involve behaviors such as fidgeting, inability to remain seated, or talking excessively (Bush, 2010). With these symptoms in mind, three subtypes of ADHD are recognized: a predominantly inattentive type, a hyperactive/impulsive type, and a combined type (DSM-V; American Psychiatric Association [APA], 2013). Additionally, individuals with ADHD might experience related difficulties, such as disorganization, forgetfulness, and challenges in goal setting and planning, which can exacerbate struggles in academic, social, and work environments (Bush, 2010).

ADHD is among the most common childhood neurodevelopmental disorders, and it frequently persists into adolescence and adulthood (Arnold et al., 2020; Bush, 2010; Faraone & Biederman, 2005). However, its symptoms may present differently with time and developmental maturation (Biederman et al., 2000); most adults with ADHD continue to struggle with symptoms of inattention, whereas symptoms of

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hyperactivity and impulsivity may wane with age (Biederman et al., 2000; Hervey et al., 2004). Despite this shift, ADHD remains a significant challenge for individuals, continuing to affect academic achievement (Jangmo et al., 2019), career progression, and social interactions throughout the lifespan (DuPaul et al., 2009; Lipka et al., 2020).

The etiology of ADHD remains an area of active research (Sharma & Couture, 2013; Thapar et al., 2013). Most studies agree that it is a result of a combination of hereditary and environmental factors (Nigg et al., 2010; Nikolas & Burt, 2010; Shen & Zhou, 2024). Twin and family studies have demonstrated a strong genetic component (Faraone & Larsson, 2019; Uchida et al., 2018) with the involvement of multiple gene contribution (Demontis et al., 2019). Environmental factors have also been linked to ADHD, which mostly include psychosocial variables and perinatal risk factors, such as maternal smoking, nutritional deficiencies, and low family income (Shen & Zhou, 2024; Thapar et al., 2013). Neurologically, ADHD is linked to reduced activity and neurotransmitter imbalances in areas of the brain responsible for executive functioning, including the prefrontal cortex, caudate nucleus, and cerebellum (Castellanos et al., 2006; Sharma & Couture, 2013). These alterations in brain function may contribute to the co-occurrence of other neurological dysfunctions with ADHD, such as certain forms of benign epilepsy (Rolandic, e.g., Cohen et al., 2013), highlighting the complexity of ADHD as a neurodevelopmental disorder.

Notably, while there are numerous levels of analysis in the study of ADHD (e.g., the Inhibition Model by Barkley, 1997, and the Cognitive Energetic Model (Sergeant, 2000); see Martella et al., 2020, for further details), and other detailed investigations of its physiological and neurobiological underpinnings (Cortese et al., 2012; di Michele et al., 2005), the current paper focuses on the cognitive-behavioral level. This level of analysis most closely matches the existing literature on ALL, allowing for more easily conceptualizing the intersection of ADHD and ALL.

Attention networks and ADHD

Attention is not a unitary construct but rather is comprised of several processes and networks (see Figure 1). In the influential Attention Systems Model, Posner and Petersen (1990) suggest three separate, yet interrelated networks represented in distinct anatomical areas and controlling different functions: alertness, orientation, and executive control (Fan et al., 2002). According to the Attention Systems Model (Posner & Petersen, 1990), attention dysfunction might be a result of difficulty in any one of the three subsystems. However, research has identified deficits in only two of the three attention networks in individuals with ADHD, in alertness (sustained attention, e.g., Berlin et al., 2004; Epstein et al., 2003) and executive control, but not in the orienting network (Berger & Posner, 2000; Coll-Martín et al., 2021; Johnson et al., 2008, Oberlin et al., 2005). In what follows, we briefly describe each network and how it is affected in ADHD.

Sustained attention

According to the Attention Systems Model (Posner & Petersen, 1990), the alerting network is a dual-level control mechanism; the low-level refers to physiological

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alertness, and the high-level refers to maintaining attentional focus and an optimal level of alertness during task performance, namely sustained attention (Gomes et al., 2000). Neuropsychological assessment of sustained attention requires participants to remain focused and ready to react to the presentation of rarely occurring target stimuli over a long period of time (Tucha et al., 2017), for example, using the Continuous Performance Test (CPT; Conners et al., 2000).

Sustained attention is crucial for learning, for everyday activities and cognitive development (Esterman & Rothlein, 2019; Fortenbaugh et al., 2017). Failures in sustained attention, such as vigilance decrements and fluctuations of performance, are a focus of concern, because lapses of attention in some cases, such as during car driving, can be life-threatening, and, in less extreme cases, can impair basic cognitive functions such as learning and memory (Decker et al., 2023; Unsworth & Robison 2017).

Vigilance decrements are defined as a decline in performance in sustained attention tasks as a function of time-on-task (Thomson et al., 2015) and are explained by either an *overload* or an *underload* of attentional demands. Most overload models assume that attention is a limited resource (Broadbent, 1958; Robinson, 2003; Schmidt, 2001, Tomlin & Villa, 1994) and that attentional resources are allocated to tasks as needed. Problems arise when task demands exceed the individual's attentional capacity (Park & Han, 2008; Tomlin & Villa, 1994), leading to vigilance decrements (Warm et al., 1996). In contrast, underload models assume that sustained attention tasks are monotonous and boring which leads to withdrawal of attention from the task, directing it to task-unrelated mind wandering (Esterman & Rothlein, 2019; Smallwood & Schooler, 2006), and as a result, impairing performance on the primary task (Thomson et al., 2015). Indeed, vigilance decrements and fluctuations of performance can be minimized in different ways, such as goal setting, feedback, and large incentives (Esterman et al., 2016; Robison et al., 2020).

Alerting is the primary impaired network of attention in ADHD (Marchetta et al., 2008; Tucha et al., 2017), in both the predominantly inattentive and the combined subtypes (Huang-Pollock et al., 2006), and deficits of sustained attention are part of the diagnostic criteria for ADHD specifically for the predominantly inattentive type and the combined type (DSM-V; APA, 2013). Individuals with ADHD demonstrate difficulty in sustaining their level of arousal over time both behaviorally (Johnson et al., 2008) and neurologically (see meta-analysis of Dickstein et al., 2006).

Individuals with ADHD consistently show worse performance in sustained attention in CPT tasks relative to controls, as indicated by significantly more omission errors and slower mean reaction times (Avisar & Shalev, 2011; Tucha et al., 2009). Moreover, this decrement in performance intensifies as the task proceeds due to vigilance decrements, and more strongly so in individuals with ADHD compared to controls (Tucha et al., 2009; 2017). Individuals with ADHD also show increased intra-individual variability of reaction times (fluctuations of performance) (Castellanos & Tannock, 2002; Lundervold et al., 2011; Marchetta et al., 2008). Such vigilance decrements and fluctuations of performance reflect the clinical characteristics of individuals with ADHD (Fortenbaugh et al., 2017; Tucha et al., 2017). These attentional patterns have important implications for classroom

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activities, such as reading comprehension, note-taking, and multi-step problem-solving, which require sustained attention over extended periods. Frequent attentional lapses and declining vigilance may lead to missed instructions, inconsistent engagement, and difficulties in retaining information across time.

Of relevance, individuals with ADHD may exhibit difficulty in sustained attention due to reduced motivation (e.g., Haenlein & Caul, 1987; Skalski et al., 2020; Volkow et al., 2011), given that they most often present impaired performance in uninteresting repetitive tasks, but not in interesting tasks (Bush, 2010). This reduced motivation among individuals with ADHD is associated with a disruption of the dopamine reward pathway (Volkow et al., 2011).

Orienting

Under the Attentional Systems model (Posner & Petersen, 1990), orienting refers to the process of directing attention resources toward a specific stimulus or its features. Studies comparing children (Johnson et al., 2008) and adults (e.g., Coll-Martín et al., 2021) with and without ADHD have not found differences in the orienting network, despite deficits of individuals with ADHD in the alerting and executive control networks. Thus, individuals with ADHD seem to have intact orienting abilities (Johnson et al., 2008; Mullane et al., 2011; Fabio & Urso, 2014).

Executive control

When an input captures our attention, we activate the executive control attention network to voluntarily switch and direct our attention toward it (Petersen & Posner, 2012, Posner, 2012, Posner & Petersen, 1990). Executive control are a set of general-purpose processes, which regulate one's thoughts and behaviors, are responsible for the selective deployment of attention in a goal-driven manner (Mishra, 2018), and are linked to the prefrontal cortex of the brain (Miyake et al., 2000). Executive control includes inhibitory control, working memory, mental shifting, monitoring, planning, fluency, and problem-solving (Chan et al., 2008). The current discussion will focus on three of the most frequently postulated executive control abilities in the literature, namely: updating of working memory, inhibition, and shifting of mental sets (Miyake et al., 2000; Miyake & Friedman, 2012).

Working memory allows us to actively preserve a limited amount of information while performing a cognitive task or in the face of distracting information (Shah & Miyake, 1999). For example, working memory is measured when individuals are asked to recall a sequence of digit names in reverse order (e.g., Morra, 1994). Working memory is associated with academic achievements such as reading comprehension and mathematics (Best et al., 2011; St Clair-Thompson & Gathercole, 2006) and contributes to many learning processes (Engle, 2001) including first (Carretti et al., 2009; St Clair-Thompson & Gathercole, 2006) and ALL (Linck & Weiss, 2011; Martin & Ellis, 2012).

Inhibition is the ability to suppress irrelevant dominant information deliberately. Accordingly, inhibition tasks measure the ability to suppress or withhold frequent or automatic responses (e.g., stop-signal task, Lappin & Eriksen, 1966; Logan, 1994; Stroop task, Stroop, 1935). Similarly to other executive control abilities, better

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inhibition skills are associated with better math and reading performance in preschoolers and first graders (Blair & Razza, 2007; Espy et al., 2004) and are also associated with better reading comprehension (Borella et al., 2010), word learning (Yoshida et al., 2011), and general academic achievements (St Claire-Thompson & Gathercole, 2006).

Shifting, also known as "cognitive flexibility," is the ability to shift consciously and efficiently between mental sets (Prior & MacWhinny, 2010) and to modify cognitive processes in response to changing environmental circumstances (Deák, 2003). A "more flexible" person can adaptively switch attention and action for a change of task in response to feedback, whereas a "less flexible" person tends to persist on the previous task regardless of feedback (Hung & Loh, 2020). Rule-switching paradigms are often used to assess shifting, for example, requiring individuals to respond to different dimensions of stimuli on different trials (e.g., Prior & MacWhinny, 2010). Shifting ability has been identified as particularly important for performance on complex academic tasks in math and reading (Magalhães et al., 2020; Yeniad et al., 2013), and it is associated with better reading comprehension performance in first and second language (Chung et al., 2020; Hung & Loh, 2020), as well as with better language learning (Trofimovich et al., 2007).

Deficits in executive control are commonly observed in individuals with ADHD (Barkley, 1997; Castellanos & Tannock, 2002; Willcutt et al., 2005), in both childhood (e.g., Willcutt et al., 2005) and adolescence (Martel et al., 2007), mostly in the inattentive and combined subtypes of ADHD (Castellanos et al., 2006; Martel et al., 2007). Although there is some variability in the extent and nature of these impairments (Willcutt et al., 2005), learners with ADHD show weaknesses in all three main components of executive control: working memory, inhibition, and shifting.

Thus, a meta-analysis of 26 studies shows impairments in working memory in children with ADHD relative to controls (Martinussen et al., 2005). Further, inhibition has been identified as the most consistently impaired domain in ADHD (Nejati et al., 2020) and is claimed to be the core deficit of the disorder (Barkley, 1997). For example, Wodka and colleagues (2007) demonstrated that children with ADHD made significantly more errors across three inhibition tasks, even under low working memory demands (see also Hervey et al., 2004; Lansbergen et al., 2007; Liotti et al., 2010; Rahmi & Wimbarti, 2018). Finally, although it has received less research, learners with ADHD show weaker shifting abilities as well (for a meta-analysis, see Hervey et al., 2004). Learners with ADHD also show reduced activation in brain regions associated with shifting and engage different brain regions to resolve the conflicts caused by task switching (Bálint et al., 2015, see also Miklós et al., 2019). They tend to show lower performance than those without ADHD in other executive control processes as well, such as planning (Boyer et al., 2015; Hervey et al., 2004; Kofman et al., 2008), verbal fluency (Hervey et al., 2004; Hurks et al., 2004; Takács et al., 2014), or monitoring (McLoughlin et al., 2009).

To summarize, there is abundant evidence indicating that learners with ADHD are impaired in two of the three attention networks proposed by the Attention Systems Model (Posner & Petersen, 1990), namely in sustained attention and executive control. We now turn to describe the role of these attention networks in

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language learning in order to set the stage for considering possible difficulties of individuals with ADHD in ALL.

Attention networks and ALL

The role of attention in ALL has been most prominently discussed through the Noticing hypothesis of Schmidt (1990), who suggested that conscious attention to the input is necessary for ALL to occur. For example, to acquire phonology, attention should be directed to the sounds of target language input, but to acquire syntax, one must pay focal attention to the order of words and the meaning they are associated with (Schmidt, 1995). The Noticing hypothesis and the relationship between attention and ALL has received some empirical support (Dolgunsöz, 2015; Godfroid & Uggen, 2013; Leow, 1998). Thus, beginner learners of German as a second language who paid attention to irregular forms, as measured through eye-tracking, acquired those forms better (Godfroid & Uggen, 2013; see also Dolgunsöz, 2015). Although the Noticing hypothesis is framed within cognitive theories of attention, such as the Attention Systems Model (Posner & Petersen, 1990), it does not directly explore the subcomponents of attention, as exemplified in the discussion above. In what follows, we discuss how the subcomponents of the Attention Systems Model may be linked to language learning.

Sustained attention

There is some evidence supporting the role of sustained attention in language learning and processing. For example, infants who are able to sustain their attention to social stimuli show larger vocabulary knowledge at an older age (Masek et al., 2021; Salley et al., 2013), and sustained attention is also necessary for coordinating language production. Moreover, sustained attention is linked to better procedural/sequence learning (West et al., 2021), which underlies implicit language learning (Granena, 2013).

The role of sustained attention in language is further emphasized in studies on clinical populations characterized with language deficits such as learners with Developmental Language Disorder (DLD; Boerma et al., 2017; Ebert & Kohnert, 2011; Ebert et al., 2019; Finneran et al., 2009; Park et al., 2019). These studies document deficits in sustained attention in individuals with DLD who demonstrate weaknesses in vocabulary, morphosyntax, written language, and social language (e.g., Ebert & Kohnert, 2011). Accordingly, sustained attention may be one of the underlying processes supporting typical language learning and reduced sustained attention capacity could contribute to language learning difficulties.

Importantly, however, most of the research linking sustained attention to language has been conducted on first language, and the extent to which sustained attention subserves these processes in ALL is still understudied. Arguably, sustaining attention is necessary for processing complete linguistic input when learning a new language. For example, successful word learning requires the learner to sustain focus in order to form an association between an object and a label (Mueller & Tomblin, 2012), and successful grammar learning requires the learner to stay alert to different features of the language including less salient grammatical

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features (Ebert et al., 2019). A breakdown in sustained attention during an additional language listening task, for instance, may result in the learner missing crucial elements in a spoken sentence, such as verb endings or function words, which can hinder comprehension and reduce the opportunity to internalize correct grammatical patterns. Such momentary lapses may cause learners to overlook linguistic cues essential for successful language acquisition.

Orienting

Although not explicitly examined, one may speculate that the orienting network is relevant to language learning because learners need to be able to selectively focus on relevant linguistic input (Ebert et al., 2019). Presumably, when learners direct their attention toward the relevant language input, this may enhance and facilitate its detection (Tomlin & Villa, 1994). Schmidt (2001) proposed that orienting is related to instructional techniques, suggesting that learners' attention can be shifted/biased towards a linguistic form increasing the likelihood of detecting formal distinctions, such as those which differ from the first language. Importantly, these are mostly theoretically motivated hypotheses, and the relationship between orienting and language learning, including ALL, has received scant study and still requires empirical validation. To move beyond speculation, future research could test whether individual differences in orienting capacity (e.g., as measured by spatial cueing tasks) predict learners' ability to notice and internalize low-salience features in classroom instruction. Experimental designs might also manipulate orienting cues (e.g., visual or auditory highlighting of target forms) to assess whether enhancing orienting improves learning outcomes in ALL contexts.

Executive control

The executive control network has been most strongly linked to ALL. Of note, there is a large body of literature on executive control and bilingualism attempting to examine whether extensive language use or bilingualism enhances executive control abilities (Prior & Gollan, 2011; see Gunnerud et al., 2020 for a recent review), which is beyond the scope of the current paper. Only a few studies examined the opposite direction, relevant for current discussion, of whether better executive control abilities facilitate language learning. As elaborated below, these (relatively sparse) studies attempt to capture causality by determining order of events with executive control abilities measured prior to ALL.

The notion that executive control is relevant for ALL arises because during ALL target and non-target linguistic representations become active to some degree and compete for selection (Jared & Kroll, 2001). Theories emphasizing language inhibition (e.g., the inhibitory control model, Green, 1998) assume that this simultaneous activation of representations from two or more languages requires the learner to engage in conflict resolution processes, to inhibit and negotiate emerging responses and interference from the non-target language (e.g., inhibiting a certain word in English (L1) while trying to retrieve the corresponding one in Spanish (L2)). For example, in a listening task, difficulties in inhibition may result in the learner persistently activating L1 translations, making it harder to integrate the incoming L2

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or L3 sentence meaningfully. Moreover, learners are expected to utilize working memory when retrieving and producing language adhering to complex grammatical rules in written or oral form, thus limited working memory capacity may make it difficult to hold sentence components in mind while applying syntactic rules, resulting in omissions or mis-ordered structures. In the same manner, additional language learners are often required to switch between their different languages and to monitor the linguistic environment in order to identify the appropriate language (Mishra, 2018). For example, difficulty disengaging from the prior language or rule set can lead to slower responses or inappropriate language use.

Empirically, a few studies have documented the contribution of executive control components to ALL (e.g., Chung et al., 2020; Linck et al., 2014). For example, using an artificial language learning paradigm, Kapa and Colombo (2014) demonstrated that inhibitory control was predictive of learning in adults and that shifting and attentional monitoring predicted learning in children. Studies measuring executive control abilities before language learning have found that inhibition was significantly associated with second language learning in children in an immersion setting (Woumans et al., 2019), and that working memory was positively related to learning gains in college students studying an additional language in a classroom setting (Linck & Weiss, 2015).

Given the scarcity of studies directly examining the involvement of the attention networks in ALL, more research is needed to substantiate the proposed links, as exemplified by the dashed blue lines in Figure 1. Nonetheless, the overall pattern emerging is one in which the attentional processes of sustained attention and executive control are important to language learning.

ALL in individuals with ADHD

The previous sections show that learners with ADHD exhibit difficulties in sustained attention and executive control networks, and that these same attention networks are likely linked to language learning. Here, we combine those two lines of thought and discuss the possible impact of ADHD on ALL (see Figure 1, dashed green line) and review the limited body of existing research.

Theoretical predictions

First, learners with ADHD have difficulty sustaining their attention for a long time on a specific task and struggle to complete tasks due to vigilance decrements and/or mind wandering during tasks (Tucha et al., 2017). Accordingly, because ALL is an effortful and resource-demanding task, it might lead to depletion of the attentional resources, in line with overload theories of sustained attention (Warm et al., 1996). As a result, the deficits in sustained attention in learners with ADHD are likely to disrupt ALL and might lead to incomplete processing of the language input.

Second, we outline two possible links between the orienting abilities in ADHD and ALL. The first possibility is that because the orienting network is generally intact in learners with ADHD (Coll-Martín et al., 2021; Johnson et al., 2008), they will show intact orientation abilities in ALL as well. The second possibility is that because ALL is a highly demanding task, orienting abilities will be taxed in such

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contexts. Thus, learners with ADHD will show difficulties in orienting, due to an overload of the attentional demands in ALL, which will result in missing relevant input. Studies examining the effect of task load on orienting attention have presented mixed results (see review of Santangelo & Spence, 2008), suggesting either automatic orienting regardless of different task loads (Santangelo & Spence, 2007), or attenuation of orienting attention in demanding tasks (Bobak & Langton, 2015). Thus, future studies should examine whether the challenging demands of ALL interfere with orienting abilities in learners with ADHD.

Third, the difficulties in executive control of learners with ADHD might negatively affect ALL. In particular, the limited working memory capacity of learners with ADHD (Leons et al., 2009; Martinussen et al., 2005) might constrain successful language learning, because comprehending or producing language requires learners to simultaneously retrieve appropriate vocabulary, grammar, and syntactic constructions and manipulate them for further use. In addition, the impaired inhibition abilities of learners with ADHD (Hervey et al., 2004) might make it more difficult for them to inhibit interference from the non-target language when learning a new language. Finally, learning an additional language requires shifting abilities, such as switching forward and backward from the target language to the previously known language/s, or shifting attention to a certain learning goal, such as from focusing on the meaning to focusing on the form of a word within the additional language. Learners with ADHD are worse at changing perspectives and switching between mental representations (Miklós et al., 2019), which might add a further burden to the task of learning an additional language, making it more challenging for the learners with ADHD than it is for their typically developing peers.

Notably, the discussion in the current paper is framed around general trends in sustained attention and executive control challenges commonly observed in individuals with ADHD, but clearly there is substantial variability in how ADHD manifests across individuals (Nikolas, & Nigg, 2013; Willcutt et al., 2005). Nonetheless, the current approach allows us to highlight patterns that are most relevant to understanding the intersection of ADHD and ALL, serving as the basis for additional future work regarding individual differences in learners with ADHD.

Empirical evidence

To understand the intersection between ADHD and ALL, we turn to available empirical studies which examine ALL in individuals with ADHD. While the current paper is not a systematic review, we conducted a comprehensive search for relevant studies, using electronic searches of databases such as PsycINFO, ERIC, and Google Scholar, as well as examination of reference lists from identified publications, in which various combinations of descriptors were used including (*Additional/Foreign language learning, English additional/Foreign language learners, additional/Foreign language classroom, additional/Foreign language, Attention deficit/hyperactivity disorder (ADHD), attention*). The inclusion criteria for ALL were broad, including studies involving children or adults diagnosed with ADHD and examining any aspect of ALL/processing. Studies that examined participants with other learning disabilities and neurological deficits besides ADHD were not included.

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Our search identified only 11 studies published between 2004 and 2024, which are summarized in Table 1. Unfortunately, the information provided regarding the linguistic background of participants and the linguistic context in which the additional language was learned was often not comprehensive. These studies, implementing a range of methodologies including qualitative, quantitative, and position papers, provide initial evidence of difficulty in ALL among learners with ADHD.

The extant literature examined varied aspects of ALL in learners with ADHD. Some reported on the degree to which learners with ADHD are able to complete ALL courses (Leons et al., 2009; Sparks et al., 2004), others include subjective assessments of the efficacy of various learning strategies (Kinasih & Rochmawati, 2020; Leons et al., 2009; Liontou, 2019; Paling, 2020; Sabet et al., 2015), and others focused on teachers' experiences (Indrawati, 2023; Turketi, 2010). Importantly, scarce empirical evidence exists on the extent to which sustained attention difficulties and impaired executive control processes, specifically, might affect learners with ADHD in ALL.

One study collecting retrospective self-reports observed that learners with ADHD reported greater difficulties in focusing attention during language learning sessions (Paling, 2020). Importantly however, such retrospective self-report measures might be biased by the participant's diagnosis. Similarly, Turketi (2010) relied on retrospective discussions based on her experience as an English as a second language teacher for children with ADHD (see Indrawati, 2023, for a similar report on teachers' experiences). Turketi observed that all four language skills (i.e., reading, writing, listening, and speaking) presented a variety of challenges for learners with ADHD. She further argued that learners with ADHD receive disrupted language input and struggle in dealing with the amount of information and distractions in their environment, leading to confusion between important and irrelevant information. The difficulty of learners with ADHD in processing input is often reflected in reading, listening comprehension, and understanding the meaning of words. In learning to read, for example, learners need to inhibit the reading rules of their previous languages in order to learn the new rules of the additional language, which is described as a confusing and frustrating experience for learners with ADHD. In addition, Turketi describes challenges of learners with ADHD in speaking and writing the additional language which are reflected in poor comprehension of language structures, poor vocabulary and pragmatics, and slow production speed of written and spoken language. Notably, though these are important insights from an experienced teacher, they should be empirically examined in the future.

Using more experimental approaches, Marashi and Dolatdoost (2016) found that the severity of symptoms among individuals with ADHD who are learners of English as an additional language was linked to lower scores in speaking complexity and accuracy. The authors suggest that the learners' limited sustained attention and working memory led to more errors in their speech. Additionally, a study by Grob et al., (2023) found that adult learners with ADHD showed lower performance in a task assessing the ability to discriminate unfamiliar languages compared to learners without ADHD. The task included both simple (1 utterance) and difficult (2–3 utterances) conditions. Learners with ADHD showed lower performance in the

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Table 1. Summary of studies on ADHD and ALL

Study type	Authors (year)	Participants' characteristics	Inclusion criteria	Study description	Notes
Theoretical/ position paper	Turketi (2010)	Author's experience in teaching English to children with ADHD	N/A	The paper discusses the characteristics of input and output speech issues (reading, listening, writing, and speaking) for ADHD students in additional language classes. Additionally, the paper reviews methods and approaches in teaching English as additional language to ADHD children. Finally, the author provides examples of activities that can be applied in the additional language classes which will make the process fruitful, both for the ADHD and non-ADHD children.	
Position paper	Kałdonek-Crnjaković (2018)	N/A	N/A	Description of potential effects that ADHD may have on ALL, while distinguishing between inattention and hyperactivity/ impulsivity subtypes of ADHD. Suggests potential future research directions.	• Does not address the Attention Systems Model.
Qualitative	Indrawati (2023)	Three teachers (one for fifth-grade students, two for eighth-grade students)		Data from interviews and field notes of three teachers for English as an additional language for students with ADHD were analyzed. The results showed difficulties in writing, reading comprehension, speaking, and listening.	

(*Continued*)

Table 1. (*Continued*)

Study type	Authors (year)	Participants' characteristics	Inclusion criteria	Study description	Notes
Qualitative and quantitative	Leons, Herbert and Gobbo (2009)	67 college students (unknown age range) and unknown number of additional language instructors	Participants were students at a college that exclusively serves students with learning disabilities and ADHD, in which they undergo psychoeducational testing as part of the college admission procedure. No additional confirmation of ADHD diagnosis was conducted in the study.	Data collected from students with ADHD and instructors included rating sheets, class observations, oral proficiency assessments, and interviews. Eighty percent of students with ADHD showed proficiency gains following participation in additional language classes. Further, students most consistently reported that visuals and repetition supported their learning. The authors make recommendations for instruction and curricular design.	
Quantitative	Sparks, Javorsky and Philips (2004)	68 college students with ADHD (mean age at graduation 22.10 years)	Participants provided documentation of an official ADHD diagnosis (from a private practice or public schools). A confirmation of diagnosis by the university's student health services, including review by a physician was conducted.	A record study of college students with a diagnosis of ADHD who enrolled in additional language courses, over a 5-year period. Eighty-three percent of students with ADHD received a passing grade in their additional language classes. The authors thus encourage ADHD students to use instructional accommodations in additional language courses.	• Data from students with ADHD who are not enrolled in such courses were not analyzed. • The data was not compared to completion rates for students without ADHD. • ADHD students who receive final passing score in additional language courses might still struggle in ALL.

(*Continued*)

Table 1. (*Continued*)

Study type	Authors (year)	Participants' characteristics	Inclusion criteria	Study description	Notes
Quantitative	Sabet, Farhoumand, Zafarghandi and Naseh, (2015)	8 students with ADHD (mean age 12.87 years) and 8 students without ADHD (mean age 13.25 years).	Participants who met the criteria for ADHD based on the Child Symptom Inventory-4 (CSI-4) forms filled out by parents. Underwent confirmation of the diagnosis through interviews conducted by a psychologist.	The study examined the effect of focus strategies, compared to rote learning, on vocabulary learning of high school students with ADHD. Two focus strategies (key word method and fold overs technique) lead to improved performance for all students (with or without an ADHD diagnosis).	• Study likely underpowered. • No corrections for multiple comparisons.
Quantitative	Marashi & Doolatdoost (2016)	61 elementary school students with ADHD (age range 10 to 14 years)	Participants who met the criteria for ADHD based on the Child Symptom Inventory-4 (CSI-4) forms filled out by parents and teachers.	Students studying English as an additional language completed the sample speaking section of the Key English Test, and their ADHD symptoms were reported by teachers and mothers as a score between 9 and 18. Severity of ADHD symptoms was significantly negatively correlated with speaking complexity and accuracy and significantly positively correlated with speaking fluency.	• Relies on correlational analyses.
Quantitative, self-report	Liontou (2019)	10 elementary school students with ADHD (age range 9 to 12 years)	Participants provided documentation of an official ADHD diagnosis (no confirmation of the diagnosis was conducted in the study).	Students were enrolled in a 1-year program including Technology Enhanced Learning of English as an additional language. Participants' attitudes at year's end were fairly to very satisfactory with the program, based on a five-point Likert scale attitude questionnaire.	• Relies on self-report attitudes. • Did not provide pre- and posttest measures in order to determine the efficacy of the intervention for learners with ADHD.

(*Continued*)

Table 1. (*Continued*)

Study type	Authors (year)	Participants' characteristics	Inclusion criteria	Study description	Notes
Quantitative	Kinasih and Rochmawati (2020)	50 preschool English teachers in Indonesia	N/A	Data collection method included questionnaires, interviews, and in-class observations. Various teaching methods are described, including electronic media, flashcards, and songs. Teachers report teaching difficulties including attracting students' attention and keeping them focused.	• No information on student diagnoses of ADHD is included – not clear what percent of students in observed classrooms had ADHD.
Quantitative, self-report	Paling (2020)	43 ADHD and 43 non-ADHD adult language learners (age range in both groups 31–50 years).	Participants provided documentation of an official ADHD diagnosis (no confirmation of the diagnosis was conducted in the study).	Participants completed retrospective questionnaires regarding their language learning experiences. Learners with ADHD reported more difficulty focusing and maintaining attention during learning, but no group differences were reported for memory, grammar, speaking, listening, reading, or writing. Responses to questions regarding effective instruction accommodations were not analyzed statistically, but it seems that ADHD learners favored using multimedia and visual solutions more than controls. Descriptively, learners with ADHD also reported lower levels of current proficiency and lower levels of confidence in using the studied language.	• Retroactive self-report measures might be biased by participants' diagnosis. • Some results remain at descriptive level.

(*Continued*)

Table 1. (*Continued*)

Study type	Authors (year)	Participants' characteristics	Inclusion criteria	Study description	Notes
Quantitative	Grob et al., (2023)	25 music educated adults. 25 music-naïve adults. 25 ADHD adults with low music practice and education.	N/A	Participants completed a music perception task, an additional speech perception task and a short-term memory task. The study found that ADHD participants had lower performance in the difficult level of additional speech perception task and in the complex level of music perception task, compared to controls. No differences were found between ADHD and controls in short-term memory task.	• No information on the diagnoses of ADHD and inclusion criteria is included.

difficult condition which required greater cognitive capacity and attentional control. Since the ability to discriminate unfamiliar speech is important for ALL (Kusumoto, 2012; Silbert et al., 2015; Snow & Hoefnagel-Höhle, 1979), these findings suggest that learners with ADHD might encounter difficulties in ALL.

Taken together, these studies support an initial notion that the core cognitive deficits of ADHD might indeed negatively affect ALL (Kałdonek-Crnjaković, 2018; Kinasih & Rochmawati, 2020; Leons et al., 2009; Turketi, 2010). However, much additional empirical evidence is necessary to substantiate this link and the intersection of ADHD and ALL more generally.

A call for future research

The current paper identified a significant gap in the literature and demonstrated that although there are theoretically sound arguments supporting the notion that learners with ADHD might encounter unique challenges in ALL, there is not enough empirical evidence on this issue. In what follows, we first outline general principles of a research program testing the intersection of ADHD and ALL and then illustrate two specific cases.

Most importantly, there is an urgent need for studies systematically comparing learners with and without ADHD, to examine whether there are consistent group differences in various aspects of ALL. This is necessary, because ALL is a complex endeavor, and observed group differences in one aspect of learning (e.g., grammar) will not necessarily generalize to other aspects of learning (e.g., vocabulary). Further, the possible impact of ADHD on ALL should be carefully examined in various age groups, across different stages of learning (beginner, intermediate, and advanced) and for different language combinations. Other relevant learner variables, such as prior linguistic experience, socioeconomic status, and cognitive ability, should also be systematically considered. Such broad investigations should be complemented by more targeted studies, specifically examining the possible impact of the attention network deficits in ADHD on ALL.

Such studies could adopt a variety of experimental approaches. For example, cross-sectional comparisons can be used to assess whether learners with ADHD consistently perform differently from non-ADHD peers in specific language domains, such as grammar or vocabulary. Longitudinal designs would allow researchers to track learners' progress over time, assessing whether the learning curve differs between groups and identifying whether learners with ADHD benefit from prolonged exposure or specific types of instruction. Additionally, precise online methods like eye-tracking can help reveal real-time attentional allocation during tasks such as sentence reading or vocabulary learning, identifying whether learners with ADHD show different gaze patterns or processing speeds or increased effort (e.g., as measured via pupillometry).

One illustration of a targeted domain for research is possible differences between implicit and explicit mechanisms. Explicit language learning involves conscious hypothesis testing and rule memorization (Ellis, 1994, 2015). In contrast, implicit learning is an unconscious process where learners acquire language elements, such as sounds and rules, based on their frequency in the input (Ellis, 2009, 2015).

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For example, vocabulary learning often relies on explicit processing, while grammatical structures may benefit more from implicit learning.

ADHD-related challenges may interact with these learning mechanisms. Explicit learning may place greater demands on attention and working memory resources, as it requires learners to consciously focus on rules, memorize vocabulary, and monitor their own performance—processes that can be especially effortful for individuals with ADHD. As such, purely explicit learning approaches may prove cognitively demanding for this population, particularly in the absence of external structure or support.

The role of attention in implicit learning, however, remains debated (Jiménez, 2003). Some studies suggest that attention is necessary for implicit learning to occur (Franklin et al., 2016; Nissen & Bullemer, 1987; Staels & Van den Broeck, 2017), while others argue that it can proceed with minimal attentional resources (Cleeremans & Jiménez, 1998; Frensch et al., 1998). This debate influences predictions on how learners with ADHD manage ALL. Specifically, if some level of sustained attention is still needed to notice and internalize regularities in the input, learners with ADHD may still be disadvantaged in implicit learning if attention lapses are frequent or prolonged, whereas if minimal attention is required, their implicit learning may remain intact. The limited body of research on implicit lab-based artificial language learning in learners with ADHD has yielded mixed results. Interestingly, some studies such as Rosas et al. (2010) found that children with ADHD excelled in implicit language learning, recognizing regularities in an artificial grammar learning task earlier than typically developing children. However, other studies showed reduced performance of learners with ADHD on artificial grammar tasks (Domuta & Pentek, 2000; Laasonen et al., 2014).

Future research should aim to address these inconsistencies by exploring the conditions under which learners with ADHD succeed or struggle in implicit and explicit ALL. Such work could inform targeted instructional strategies. To wit, if evidence supports the conclusion that implicit learning requires little or no attentional resources, then implicit learning approaches such as instructional designs that rely more on repetitive and input-based exposure (e.g., reading tasks with high-frequency target structures, or repeated exposure to patterned language in context) should be incorporated in ALL instructional methods and interventions aimed at learners with ADHD. On the other hand, if implicit learning is negatively influenced by limitations of sustained attention, explicit ALL, where the structure, rules, instructions, and learning goals are overt and guided, should be emphasized among individuals with ADHD (e.g. Akbasli, 2017). For example, structured grammar instruction with metalinguistic explanations and immediate corrective feedback or the use of visual organizers that clearly outline language rules and how these rules are different from previous linguistic knowledge may help learners maintain focus and engage their executive control.

A second example is research focusing on whether the challenges that individuals with ADHD have in executive control, specifically in inhibition, have consequences for ALL. In particular, previous linguistic knowledge might facilitate ALL due to cross-language similarities (Flynn et al., 2004; Hirosh & Degani, 2018; Prior, 2014) or might impede ALL, when learners need to inhibit previous irrelevant linguistic knowledge (Abbas et al., 2021; Prior et al., 2017). This process of overcoming cross-

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language interference is expected to be particularly challenging for learners with ADHD who show impaired inhibitory control (Barkley, 1997). Thus, future research should examine to what extent previous linguistic knowledge of learners with ADHD affects ALL. This can be achieved either by using group comparisons of learners with and without ADHD, or by analyzing individual differences within learners to examine the relation between inhibitory control difficulties and susceptibility to cross-language influences.

Obviously, future studies comparing ALL in individuals with and without ADHD, including those focusing on the specific attention networks involved, should also take into account additional relevant factors. For one, the population of learners with ADHD, like other clinical populations, reflects a spectrum with great individual variability (Geurts et al., 2008). Thus, future research should take into account the particular profile of individual learners (e.g., ADHD subtypes). Additionally, learners' age is an important domain to consider. Although symptoms of inattention remain stable across the lifespan (Hervey et al., 2004), suggesting that both children and adults with ADHD may face challenges in ALL, their specific manifestations may differ across the lifespan. For instance, the involvement of implicit and explicit learning in ALL may change with age and cognitive maturity, leading to differential involvement of the attention networks.

Importantly, although the current paper has focused on the negative impacts of ADHD on ALL, there might be positive effects as well. For example, Marashi and Dolatdoost (2016) found that learners with more severe symptoms of ADHD had higher fluency when speaking English as an additional language. According to the authors, the hyperactive and impulsive side of ADHD allowed these learners to produce more language output, which presumably offers more communication and learning opportunities in ALL.

Additionally, although learners with ADHD might face an additional burden when learning a new language, we should bear in mind the possible long-term benefits of bilingualism on the executive control network that is evident in a large body of literature (review in Bialystok et al., 2009). To the extent that such effects are present within the population of individuals with ADHD, one might expect that ALL would in fact lead to positive consequences in terms of the attentional network of these individuals. Only a few studies examined the consequences of multilingualism for individuals with ADHD. One study found evidence for improved executive functions in bilinguals relative to monolingual individuals with high ADHD symptomology (Sharma et al., 2022). In contrast, other research did not find such improvements in executive function when comparing multilinguals to bilinguals with ADHD (Mor et al., 2015). Yet other studies suggest a more nuanced relationship, indicating that the interaction between bilingualism and executive functions in individuals with ADHD may depend on various factors (Bialystok et al., 2017). These findings highlight the need for future research to explore whether and how ALL might support individuals with ADHD.

In summary, future research needs to systematically examine the effects of ADHD on ALL with more detailed information in order to map both strengths and challenges. Such nuanced understanding is necessary for developing differentiated teaching and intervention programs. Importantly, research on learners with ADHD is expected to benefit not only these learners themselves but also to contribute to

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more global understanding of the interplay between attention networks and ALL. Such an understanding will, in turn, allow educational systems to provide all learners with tailored services and interventions in this important learning domain.

Conclusion

The current paper discussed the potential impact of ADHD on classroom ALL. While little empirical work investigating this issue is currently available, we believe this is an important avenue for future work: Do learners with ADHD face greater challenges in classroom ALL compared to their peers (see Figure 1)? Specifically, might the limited sustained attention of learners with ADHD constrain their ability to focus on the stream of linguistic input in the class and on different complex features of the language? And what are the implications of impaired executive control of learners with ADHD on the complex task of ALL?

To conclude, the rapidly rising importance of ALL requires researchers to rise to the challenge of mapping the specific difficulties of learners with ADHD. Once this goal is achieved, sound evidence-based intervention programs can be developed, with the goal of supporting all learners and increasing equity in education.

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Competing interests. The authors declare none.

Note

1 "ALL" in this paper refers to the instructed second language, third language, and any additional languages.

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