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Can executive functioning contribute to the diagnosis of SLI in bilingual children?

A study on response inhibition

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Language tests often fail to diagnose specific language impairment (SLI) in bilinguals due to the confounding impact of SLI and bilingualism on language. The present study focuses on the contribution of executive functioning to the diagnosis of SLI in bilinguals. Performance of monolingual and bilingual children with and without SLI on a task tapping response inhibition was assessed. Results revealed a negative effect of SLI but no effect of bilingualism. The diagnostic accuracy of the task was also estimated. Sensitivity and specificity were low, suggesting that response inhibition could not be considered as a reliable clinical marker of SLI. Although the results at the group level showed that children with SLI seemed more at risk than their typically-developing peers for a deficit in response inhibition, our results on diagnostic accuracy challenge the hypothesis of a relationship between deficits in language and deficits in inhibition in children with SLI.

Keywords: Executive functioning, SLI, bilingualism

1. Introduction

1.1 Disentangling the effects of SLI and bilingualism

Specific language impairment (SLI) is defined as a language deficit not explained by other clinical conditions. The diagnosis of SLI currently relies on behavioral data, using both inclusionary and exclusionary criteria. On the one hand, the presence of a significant language deficit must be established using standardized language tests. On the other hand, deficits such as hearing disabilities, neurological deficits, mental retardation or socio-emotional disorders must be excluded (or it must be ascertained that symptoms of those conditions do not explain the

language delay; Bishop, 2014). Children with SLI can show poorer phonological ability than their typically-developing peers (e.g., Dollaghan & Campbell, 1998), word retrieval difficulty (e.g., McGregor, Newman, Reilly, & Capone, 2002; Messer & Dockrell, 2006), and grammatical deficits in both production and comprehension (Leonard, 2014). In many languages, the linguistic characteristics of SLI have been described in a fair amount of detail, suggesting diagnostic markers in individual languages. In particular, children with SLI struggle with specific areas of grammar but the areas affected also depend on the language they are acquiring. For example, English-speaking children with SLI have problems with the acquisition of verbal inflection such as the third person singular -s in present tense (Rice & Wexler, 1996), while French-speaking children with SLI struggle with object clitic pronouns (Paradis, 2004). Language tests ideally target those specific grammatical structures and are therefore language-specific. However, the same range of language difficulties is observed in the early stage of second language acquisition in successive bilingual children (Grüter, 2005; Paradis & Crago, 2000, 2004; Paradis, Rice, Crago, & Marquis, 2008). In contrast to simultaneous bilinguals who usually learn two languages from birth, successive bilingual children are typically exposed to a first language (L1) from birth in the home context and start being exposed to a second language (L2) when entering pre-school around the ages of three to four (Lakshmanan, 2012). Even if they are developing typically, they do not acquire their L2 as smoothly as monolinguals. They start learning the language later and are faced with reduced exposure to the language on a daily basis. Research that has compared the language of monolingual children with SLI (MOSLI) to that of typically-developing successive bilingual peers (BITD) has shown that they show similar language characteristics: As a consequence, the linguistic profiles of these groups, especially in production, have been called ‘two of a kind’ (Crago & Paradis, 2003). The overlap between the language characteristics of MOSLI and BITD children makes it problematic to diagnose SLI on the basis of productive language measures alone.

Due to the growing immigration over the past decades in Europe the need for disentangling these two groups and for identifying the children with SLI among bilingual children has become more urgent. The proportion of children growing up in a bilingual context in Europe is currently estimated at around 15–20% (<http://www.bi-sli.org>). Most of these bilingual children are from migrant populations and they usually grow up in the context of successive bilingualism. As just mentioned, performance in the second language of BITD children in some aspects resembles that of MOSLI children in their early stages of acquisition. SLI in bilingual children, on the other hand, must affect both languages by definition. Diagnosis should therefore ideally be done on the basis of assessment of both languages. This is, however, often unfeasible due to the lack of diagnostic instruments

in many languages. Such a lack of instruments is common for the L1 of children of migrant families (Kohnert, 2010) and so diagnosis tends to take place on the basis of the L2 only. This diagnosis is problematic due to the confounding factors of SLI and bilingualism. Therefore, a diagnosis of SLI based on the assessment of a non-linguistic area that is problematic for children with SLI but not for successive bilingual peers might offer a solution to the diagnostic confound in successive bilinguals.

An increasing body of research has shown in fact that SLI is not confined to the language domain but is associated with limitations in processing information in general that extend to the non-verbal domain (for a review, see Schwartz, 2009). Inherent to the processing accounts of SLI is the view that language problems of children with SLI derive from a deficit in information processing. Some authors have argued that this deficit hampers the processing of the language input necessary to build stable grammatical representations. Hence, children with SLI would derive less benefit from language exposure than typically-developing (TD) peers and would need more time to be able to detect the recurring linguistic patterns in the input (Joanisse & Steinberg, 1998, 2003; Leonard, 2014; Montgomery, 2000; Montgomery, Magimairaj, & Finney, 2010). Others have suggested that processing limitations affect the accurate use of language knowledge during language use in real-time, such as grammatical accuracy (Bishop, 1994) or word retrieval (Epstein, Shafer, Melara, & Schwartz, 2014). However, the nature of the processing limitations in SLI remains debated. Limitations in processing speed (Bishop, 1992; Kail, 1994) or in processing capacity (Hoffman & Gillam, 2004) have been proposed. More recent research has pointed to a SLI disadvantage in executive functioning (EF) (Henry, Messer, & Nash, 2012; Kapa & Plante, 2015; Im-bolter, Johnson, & Pascuale-Leone, 2006; Roello, Ferretti, Colonnello, & Levi, 2015; Vugs, Hendriks, Cuperus, & Verhoeven, 2014). EF is a general term that embraces a range of different cognitive operations necessary for problem-solving activities, requiring complex and non-routinized thoughts and actions (Miyake & Friedman, 2012; Pennington & Ozonoff, 1996). A distinction is traditionally made between three major types of EF (Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000): updating, shifting and inhibition; these terms refer to the updating of on-going information, the flexible adjustment of actions, and the inhibition of irrelevant behavior respectively. Correlations among these three different EF components have been shown to be fairly low, indicating that they indeed reflect different cognitive processes (Miyake *et al.*, 2000). One influential theoretical framework associated with the study of EF is the tripartite model of working memory of Baddeley (Baddeley & Hitch, 1974; Baddeley, 2003). This model consists of two domain-specific systems, one dedicated to verbal processing and one to non-verbal processing. Both are dependent upon a third domain-general component, the central executive. EF is

commonly compared to the central executive that controls and supervises the different cognitive operations within working memory. More precisely, EF is often viewed as a specification of the central executive by identifying the different types of sub-processes, that is different executive functions implied in the control of cognitive activities, whether verbal or non-verbal (Miyake *et al.*, 2000). The construct of EF therefore offers the advantage of specifying the different types of cognitive operations that operate during the activity of information processing. One possible explanation for the processing deficits in children with SLI is therefore a deficit in EF, or at least in some aspects of EF. If executive functions are impaired in SLI and could serve as diagnostic indices of the disorder, non-verbal measures of EF might therefore offer an opportunity for the identification of SLI in bilingual individuals. Because EF encompasses both verbal and non-verbal functioning, EF tasks that do not rely on verbal ability can therefore be used to remove the demands for language. Non-verbal EF measures should not suffer from the problem of overlap between the effects of SLI and bilingualism observed for language measures.

As mentioned above, inhibition has been traditionally considered a key component of EF (Logan, Schachar, & Tannock, 1997). Inhibition is acquired late, developing during childhood and adolescence (Diamond, 2002), and has been observed to reach maturity around age twelve (Huizinga, Dolan, & van der Molen, 2006; Klenberg, Korkman, & Lahti-Nuuttila, 2001). Inhibition has commonly been studied in children with SLI and in TD bilinguals as reviewed below. It is potentially useful in the diagnosis of SLI in bilinguals. Inhibition is not, however, a unitary concept. Different authors have distinguished different types and numbers of inhibition depending on the classification criteria they adopt (for a review, see Friedmann & Miyake, 2004). Classification criteria include for example (1) the degree of activation of the inhibition processes, that is whether the inhibition entails an active suppression of a response or a passive gating mechanism (Wilson & Kipp, 1998), (2) the nature of the inhibited content, that is whether the inhibition process operates on a behavioral response or on a perceptual information (Nigg, 2000; Wilson & Kipp, 1998), (3) the locus of the inhibited content, that is whether the interfering information is located in memory or in the environment (Friedman & Miyake, 2004; Wilson & Kipp, 1998), and (4) the composition of the inhibition task, that is whether the task has a bivalent display containing two potentially conflicting dimensions or a univalent display containing one single dimension but requiring two potentially conflicting responses (Bunge, Dudukovic, Thomason, Vaidya, & Gabrieli, 2002). Even though researchers do not fully agree on the classification of inhibition processes, a consensus has emerged on the distinction to be made between response inhibition and resistance to interference. *Response inhibition* refers to the ability to actively suppress in working memory an overlearned response that is no longer relevant and replace it with a new relevant but less

automatic one. A task tapping response inhibition typically contains one single dimension but requires two conflicting responses, one being less automatic than the other. *Resistance to interference* is the ability to resist misleading information while attending to what is relevant. A task tapping resistance to interference typically involves two conflicting dimensions, with one dimension only being relevant to the task. The distinction between the two inhibition processes is supported by the observation that both types of inhibition engage different brain areas of the prefrontal cortex and exhibit different developmental trajectories (Blasi, Goldberg, Weickert, Das, Kohn, Zolnick, Bertolino, Callicott, Weinberger, & Mattay, 2006; Bunge *et al.*, 2002). Research indicates that response inhibition develops at a faster rate than resistance to interference (for a review, see Spaulding 2010).

Inhibition has been well studied in the area of bilingualism. Research on inhibition in bilinguals has contributed to the theoretical distinction between response inhibition and resistance to interference by providing evidence that bilinguals do not show the same pattern in performance in these two types of inhibition processes. Bilinguals overall perform better or faster than monolinguals on non-verbal tasks tapping resistance to interference (but see De Bruin, Treccani, & Della Sala, 2014). This bilingual advantage is observed in both adults (Bialystok, 2006; Bialystok, Craik, Klein, & Viswanathan, 2004; Bialystok, Craik, Grady, Chau, Ishii, Gunji, & Pantev, 2005; Costa, Hernandez, & Sebastian-Galles, 2008) and children (Bialystok, 1999; Bialystok & Viswanathan, 2009; Engel de Abreu, Cruz-Santos, Tourinho, Martin, & Bialystok, 2012). Both languages are simultaneously active in bilinguals during language use, requiring therefore the gating of one language when using the other one (e.g., Kroll & Dijkstra, 2002). The bilingual advantage in resistance to interference can therefore easily be explained by the constant need of bilingual individuals in daily life to monitor two competing languages and to suppress the interfering language when using the other one (Bialystok, 2001; Bialystok & Viswanathan, 2009). The studies mentioned above suggest that bilingualism gives an advantage in monitoring two sets of competing information, even when presented non-verbally. Studies on resistance to interference in bilingual children do not necessarily mention whether they were done on simultaneous or successive bilinguals (e.g., Engel de Abreu *et al.*, 2012). The age of L2 onset does not appear to have an effect on developing an advantage in this area, but the proficiency and the regular use of the two languages on a daily basis do (Bialystok, 2001). In contrast, an absence of a bilingual effect has often been reported for non-verbal tasks tapping response inhibition (Bonifaci, Giombini, Bellocchi, & Contento, 2011; Carlson & Meltzoff, 2008; Luk, Anderson, Craik, Grady, & Bialystok, 2010; Martin-Rhee & Bialystok, 2008). The absence of a bilingual advance in response inhibition is explained by the fact that in their daily use of language bilinguals do not need to inhibit an overlearned language to activate another less automatic language.

Research on inhibition in children with SLI is relatively sparse. Most of these studies have considered inhibition as a single construct, but in fact the focus has mainly been on response inhibition. Studies that have assessed response inhibition with verbal tasks have reported poor performance in SLI children aged from 4 to 10 (Bishop & Norbury, 2005; Marton, Kelmenson, & Pinkhasova, 2007; Roello *et al.*, 2015; Spaulding, 2010) or normal performance but immature electrophysiological responses in older children with SLI aged from 10 to 12 (Epstein *et al.*, 2014). These results are not necessarily surprising giving the language demands of the tasks. Most studies that have investigated this domain using non-verbal tasks have also reported a deficit in children with SLI aged 6 to 11 (Bishop & Norbury, 2005; Henry *et al.*, 2012; Im-bolter *et al.*, 2006). But some others have not: Marton, Campanelli, Scheuer, Yoon, & Eichorn (2012) did not report any poorer performance in children with SLI aged 10 to 14 on an auditory stop signal task. In that task children had to respond to a left or right-pointing arrow displayed on a screen by pressing on a right or a left button, but withhold their response if they heard a tone before the appearance of the arrow. Noterdaeme, Amorosa, Mildenerger, Sitter, & Minow (2001) reported normal performance in SLI children aged 7 to 21 on a GO/no-GO task, where children have to press a button on GO trials and withhold their response on no-GO trials. One plausible explanation that might account for the discrepancy across studies is the age of the participants. Children with SLI who performed more poorly than TD peers were aged from 6 to 11 (Bishop & Norbury, 2005; Henry *et al.*, 2012; Im-bolter *et al.*, 2006), while children with SLI with normal performance were overall older, from 10 to 14 in one study (Marton *et al.*, 2012) and from 7 to 21 in the other (Noterdaeme *et al.*, 2001). The development of inhibition is protracted and extends until early adolescence (Huizinga *et al.*, 2006; Klenberg *et al.*, 2001), so that studies might not yield the same results depending on the age of the participants (Kapa & Plante, 2015). Children with SLI might indeed show a maturational delay in the development of inhibition processes but eventually catch up with their peers. The hypothesis of maturational delay was proposed by Epstein *et al.* (2014). In their study on response inhibition, Epstein *et al.* observed that children with SLI aged 11, despite normal performance, showed immature physiological responses comparable to those of TD children three years younger. Another plausible explanation might lie in differences between the tasks used. Each study assessing response inhibition non-verbally mentioned above used a different task. It might be the case that some tasks lead to better discrimination between SLI and TD children than others. This might depend for example on the type of response required, whether an easy button press (e.g., stop signal task in Marton *et al.*, 2012 and GO-no GO task in Noterdaeme *et al.*, 2001) or a more complex motor response involving different hand actions (e.g., hand-fist Luria task in Henry *et al.*, 2012). The type of measurement might also play a role,

that is whether performance is based on accuracy, reaction times or electrophysiological responses. Recall that Epstein *et al* (2014) did not observe any difference in accuracy between TD and SLI children aged 10 to 12 but did find a difference in electrophysiological responses. The design including the number of trials, the frequency of target and non-target trials might also have an impact. For example, the absence of a negative SLI effect in Noterdaeme *et al* (2001) can be accounted for by the equal frequency of GO and no-GO trials, which cancels the competition between an overlearned response (GO-trial) and a less automatic one (no-GO trial) necessary for measuring response inhibition. In the few studies measuring resistance to interference in children with SLI, the results are mixed. Spaulding (2010) found group differences in children age 4–5, but the use of a verbal task might have blurred the results. Noterdaeme *et al* (2001) and Lukacs, Ladanyi, Fazekas, & Kemeny (2016) assessed resistance to interference using non-verbal tasks in children aged 7 to 21 and children with a mean age of 7;8 respectively. They both reported normal performance in children with SLI. Little research is so far available on EF in successive bilingual children with SLI (BISLI). Results from the first studies in BISLI children suggest that they perform more poorly than BITD peers in resistance to interference, but similarly to their MOTD peers, which suggests a compensatory effect of bilingualism on SLI in this domain (Engel de Abreu, Cruz-Santos, & Puglisi, 2014). Little is known, however, about response inhibition in BISLI children. If bilingualism does not have any effect on response inhibition but SLI does, then we would not expect a compensatory effect of bilingualism on SLI in this domain. This would suggest that response inhibition could help identifying SLI in children, regardless of their language status (monolingual or bilingual).

EF problems related to SLI, but not positively affected by bilingualism, might be reliable indicators of SLI in the context of bilingualism. Response inhibition, by combining both a negative effect of SLI (Bishop & Norbury, 2005; Henry *et al.*, 2012; Im-bolter *et al.*, 2006) and an absence of a bilingual effect (Bonifaci *et al.*, 2011; Carlson & Meltzoff, 2008; Luk *et al.*, 2010; Martin-Rhee & Bialystok, 2008), appears to be promising if tested non-verbally. However, to date, the accuracy of response inhibition tasks in diagnosing SLI has not been fully assessed. As stated earlier, such assessment is of particular interest in the context of bilingualism where language measures can fail to differentiate between the effect of bilingualism and the effect of SLI. A nonlinguistic task may partly fill this gap. As mentioned above, previous studies did find a negative effect of SLI on response inhibition, indicating that, as a group, monolingual children with SLI were less efficient at inhibiting their response than monolingual TD peers (Bishop & Norbury, 2005; Henry *et al.*, 2012; Im-bolter *et al.*, 2006). However, a SLI effect on a particular task does not necessarily imply that this task is a clinical marker of SLI. To assess the clinical value of a task, it is necessary to assess whether group results are valid at the individual level.

Such an assessment can be done by an estimation of the sensitivity and the specificity of the task. *Sensitivity* estimates the ability of a task to detect SLI when it is really present. It refers to the proportion of children with SLI that are detected as such by the task out of the total of children with SLI (detected or not detected by the task). *Specificity* measures the ability of a task to exclude SLI only when it is really absent. It refers to the proportion of TD children that are identified correctly by the task out of the total number of children with TD (Greenslade, Plante, & Vance, 2009; Plante & Vance, 1994).

The accuracy of a response inhibition task in diagnosing SLI can tell us the extent to which SLI is related to deficits in this non-verbal EF. Estimating the diagnostic accuracy of response inhibition will not only have clinical implications but also theoretical implications by adding to the understanding of the association between language and inhibition problems in SLI.

1.2 The present study

As mentioned earlier, language tests often fail to accurately diagnose SLI in bilinguals due to the confounding impact of SLI and bilingualism on language. The present study focuses on the contribution of non-verbal EF to the diagnosis of SLI in bilinguals by investigating performance in both monolingual and bilingual children with and without SLI on a non-verbal EF task tapping response inhibition. As summarized above, research has reported a SLI disadvantage but no bilingual advantage in the non-verbal EF domain of response inhibition, making it a promising indicator of SLI in bilinguals. Additionally, assessment of these four groups of children allows us to estimate the diagnostic accuracy of the response inhibition task. This study was therefore designed to answer the following questions:

1. What is the effect of SLI, the effect of bilingualism and their combined effect on a non-verbal task tapping response inhibition?
2. To what extent can response inhibition contribute to the diagnosis of SLI in monolingual and bilingual children? In other words, what are the sensitivity and the specificity of the response inhibition task?

Previous studies have reported a deficit in young children with SLI aged 6 to 10 in the domain of non-verbal response inhibition (Section 1.1). Therefore, it is expected that a negative effect of SLI will be found. In contrast, studies comparing performance on response inhibition in monolinguals and bilinguals have reported no group difference (Section 1.1). Therefore, no effect of bilingualism is expected. This study will provide new insights into the accuracy of a response inhibition task in diagnosing children with SLI.

2. Method

2.1 Participants

Four groups of children aged between 6;0 and 8;6 participated in this study: a group of 17 typically-developing monolingual children (MOTD), a group of 19 monolingual children with SLI (MOSLI), a group of 19 bilingual children (BITD) and a group of 13 bilingual children with SLI (BISLI) (Table 1). They were all speakers of French as either L1 or L2.

TD children

Children were recruited through regular elementary schools in France. No formal assessment of typical development was done. However, all TD children were reported by teachers and/or parents to have no problems in development. TD children with a previous history of speech-language therapy or grade retention were excluded. TD children had to have non-verbal abilities within the normal range, as measured here with the Raven's Coloured Progressive Matrices (Raven, Court, & Raven, 1985). French language performance for these TD children was measured using a French standardized task of novel-word repetition. Non-word repetition has often been described as a strong clinical marker of SLI in both monolingual (Conti-Ramsden, Botting, & Faragher, 2001) and bilingual contexts (Chiat 2015; Elin Thordardottir & Brandeker, 2013). Since no standardized non-word repetition task was available in French for children aged six to eight at the time of testing, we used the novel-word repetition task, so called 'repetition of low-frequency words' developed by Chevrie-Muller and Plaza (2001) and standardized on French monolingual children. Bilinguals have been reported to perform less well than monolinguals on such tasks when assessed in their L2 (Kohnert, Windsor, & Yim, 2006; Messer, Leseman, Boom, & Mayo, 2010; Thorn & Gathercole, 1999; Windsor, Kohnert, Lobitz, & Pham, 2010). It is therefore to be expected that the BITD children will have a lower performance in our study compared to their MOTD peers (Table 1). Scores of children with SLI will also be provided for comparison.

Children with SLI

All children with SLI were diagnosed as being language-impaired by a multi-disciplinary team of neuropsychiatrists, psychologists and speech and language therapists in France. The majority of the SLI children were recruited through two diagnostic centres for language and learning disabilities, so called 'centres de référence des troubles du langage et des apprentissages' (centres of reference for language and learning disorders). One child was recruited in a SESSAD (Service d'Éducation Spéciale et de Soins À Domicile) (Services of Special Education and

Home Care). Diagnostic centres in France, as well as SESSAD, apply the usual inclusionary and exclusionary criteria of SLI as set out by the American Psychiatric Association's Diagnostic and Statistical Manual (DSM-IV) (1994) or the World Health Organization's International Classification of Diseases (ICD-10) (1993). As such, the SLI children did not present any hearing, neurological or socio-emotional deficits. In France, however, children must usually score above a standard score of 85 on a non-verbal IQ test to be diagnosed as SLI, compared to 70 in some other countries. This is frequently tested using the WPPSI (Wechsler Preschool and Primary Scale of Intelligence; Wechsler, 1989) or the KABC (Kaufman Assessment Battery for Children; Kaufman & Kaufman, 2004). Here, non-verbal IQ was checked again using the Raven's Coloured Progressive Matrices (Raven *et al.*, 1985). One child scoring 84 was, however, still included.

All children with SLI had a significant language deficit, performing on two standardized language measures at least two standard deviations (SD) below the mean, the traditional cut-off used in France for the diagnosis of SLI. Note that this cut-off is stricter than, for example, that commonly used in the United States (-1.25 standard deviations), or in Israel (-1.5 standard deviations) (Elin Thordardottir, 2015; Tomblin *et al.*, 1997), making the chance of misdiagnosis less probable. This stricter cut-off implies that the children with SLI in this study might exhibit a more severe language deficit than those in studies conducted in the United States or Israel. The standardized instruments that had been used by the clinicians for diagnosis were diverse. They included EVALO (Evaluation du Langage Oral; Khomsi, 2000), TCG (Test de Closure Grammaticale; Deltour, 1992), ISADYLE (Instrument pour le Screening et l'examen Approfondi des DYsfonctionnements du Langage chez l'Enfant; Pierart, Comblain, Grégoire, Mousty, & Noël, 1997), TVAP (Test de Vocabulaire Actif et Passif; Deltour & Hupkens, 1980), the French equivalent of PPVT (EVIP; Dunn, Thériault-Whalen & Dunn, 1993) or the French version of Test of Reception of Grammar (ECOSSE; Lecocq, 1996). This variety in the standardized instruments used reflects the common practice of French clinicians (Elin Thordardottir, 2015). One reason for this is the lack of French standardized language batteries covering the overall language performance within the domains of phonology, vocabulary and grammar at the same time. It would be preferable if the same test had been used, but this was not possible. No French language tests have been standardized for bilingual children. The SLI diagnosis in bilinguals usually combines a direct assessment of French using standardized tests for monolinguals as well as an indirect assessment of their L1 using parental information about early language development and current abilities in this language. We relied on the language scores provided by the clinicians to take a decision on inclusion of the children with SLI in our study.

Response inhibition is commonly impaired in children with ADHD (Pennington & Ozonoff, 1996). Because this study had a special focus on response inhibition, children with a diagnosis of ADHD were excluded (Section 1.1). This exclusion criterion might be considered as a selection bias in our SLI group, as the presence of ADHD symptoms is higher in children with SLI than in children developing typically (Cardy, Tannock, Johnson, & Johnson, 2010; Tannock & Schachar, 1996). Since the aim of this study was to explore the accuracy of a response inhibition task for the diagnosis of SLI, controlling for any other factors that might affect the development of response inhibition, such as ADHD, was a prerequisite. Children with visuo-spatial deficits, such as visual dyspraxia, were also excluded because a visuo-spatial task was used for assessing EF.

Monolingual children

Children were considered French monolinguals if both parents were native speakers of French and if they had been exposed to French from birth. Children were excluded if they had been systematically exposed to any other language than French.

Bilingual children

The bilingual children were all second-generation immigrants. They were all born in France to foreign-born parents. All parents were native speakers of a language other than French. All children were first exposed to French in monolingual (pre-) schools in France. Of the bilingual children ($n = 32$) 90% started being exposed to French when entering school around three years of age. The remainder had had earlier exposure in kindergarten between 6 and 21 months of age. The parental questionnaire ALEQ (Paradis, 2011) was used to obtain information about the bilingual background of the children, such as the age of onset of the L2, the length of exposure to the L2 at the time of testing, and the degree of exposure to the L1 and L2 in and outside the home. The questionnaire was translated into French and adapted, whenever necessary, to the French context. To obtain this information, the parents were asked, among other things, which language each family member was using mostly with the child – reflecting the degree of exposure to L1 (compared to L2) at home. Five gradual scores from zero to four were possible: ‘never in L1 / always in L2’ $\rightarrow 0$, ‘sometimes in L1 / often in L2’ $\rightarrow 1$, ‘half L1 / half L2’ $\rightarrow 2$, ‘often in L1 / sometimes in L2’ $\rightarrow 3$ and ‘always in L1 / never in L2’ $\rightarrow 4$. Out of the different scores, a total score of home exposure to L1 (compared to L2) as a percentage was calculated. Using the criterion of 25% of exposure (Pearson, Fernandez, Lewedeg, & Oller, 1997), children were excluded if their total score of exposure to their L1 was less than 25%. The majority of the bilingual children were mainly exposed to their L1 in the home. The bilingual children’s L1s included 13 different languages: Albanese, Arabic, Berber, Bengali, English, Khmer, Mandarin,

Portuguese, Romanian, Serbian Tamil, Turkish, and Vietnamese. The variety of L1s reflects the heterogeneity of the immigrant community in France; it was impossible to recruit enough bilingual children with the same L1. This was not a great problem for our study, since we did not expect the typological characteristics of a child's L1 to influence his or her performance on response inhibition.

Information on the language performance of bilingual children was obtained in French only (see above). Testing language performance in their L1 would have required the availability of standardized language instruments in each L1 as well as the collaboration of clinicians able to administrate any such language tests. None of this was possible.

Description of the population

Groups were matched as much as possible on age. The mean age across all groups was 7 years and 6 months. Although an attempt was made to match the groups on age, the groups were not fully comparable in terms of age distribution and average age, with the BISLI group being about 6 months older than the three other groups. An ANOVA with group as a between-subject factor showed a main effect of age, $F(3,64) = 3.29$, $p = .03$, $\eta_p^2 = .13$. Pairwise comparisons across groups revealed a significant age difference between the BISLI children and the three other groups (BISLI / MOTD: $F(1, 27) = 7.01$, $p = .01$, $\eta_p^2 = .20$; BISLI / BITD: $F(1, 30) = 8.80$, $p = .01$, $\eta_p^2 = .23$; BISLI / MOSLI: $F(1, 30) = 6.25$, $p = .02$, $\eta_p^2 = .17$). This age difference probably reflected the fact that clinicians are cautious in diagnosing SLI in bilinguals waiting longer in order to avoid misdiagnosis and confound between lack of exposure and language disorders (Crutchley, 1999). Age difference will be taken into account in the statistics, if possible, by entering age as a covariate. Children were not preselected on the basis of gender. Statistical analyses, however, revealed no significant difference in gender across groups, $F(3, 64) = .83$, $p = .48$, $\eta_p^2 = .04$ ns.

Because cognitive problems may affect language and EF development (Chapman, 1997; Rowe, Lavender, & Turk, 2006), all children were administered a nonverbal IQ test, the Raven's Coloured Progressive Matrices (Raven's Colored Matrices; Raven *et al.*, 1985). Raw scores were converted into standard scores following the norms for each age group. The mean Raven standard score across all groups was 100 (SD: 1). Mean Raven standard scores did not show differences between the groups, $F(3, 64) = 1.99$, $p = .55$, $\eta_p^2 = .03$ ns (Table 1).

Socio-economic status (SES) may also have implications on both language and EF performance (Hoff, 2006; Mezzacappa, 2004). Therefore, the number of years of education of the mother was documented.¹ The mothers of the bilingual

1. This information is missing for 1 MOTD, 1 MOSLI and 1 BISLI children.

children had a significantly lower education level than the monolinguals' mothers (9.3 compared to 13.3 years), $F(1, 61) = 18.46$, $p < .001$, $\eta_p^2 = .23$. Mothers of children with SLI had similar education levels to mothers of TD children (10;6 compared to 11;9 years), $F(1, 61) = 1.99$, $p = .16$, $\eta_p^2 = .03$ ns. Pairwise comparisons showed that the two monolingual groups did not significantly differ in terms of level of mother's education, $F(1, 32) = 3.03$, $p = .09$, $\eta_p^2 = .09$ ns, nor did the two bilingual groups, $F(1, 29) = .22$, $p = .64$, $\eta_p^2 = .01$ ns (Table 1).

Table 1. Characteristics of the four groups of participants

	MOTH (<i>n</i> = 17)	MOSLI (<i>n</i> = 19)	BITH (<i>n</i> = 19)	BISLI (<i>n</i> = 13)
Age				
mean (SD)	7.3 (0.10)	7.5 (0.7)	7.4 (0.7)	8.0 (0.7)
range	6.0–8.6	6.0–8.8	6.0–8.8	6.0–8.9
Gender-male (nb)	59% (10)	53% (10)	37% (7)	62% (8)
Raven				
mean (SD)	103 (11)	100 (9)	99 (8)	97 (7)
range	85–119	90–113	86–116	84–107
Mother education				
mean (SD)	13.1 (4)	11.8 (3.9)	9.9 (5.2)	8.6 (4)
range	10–17	9–17	0–16	0–16
Age of first exposure to French				
mean (SD)	0 (0)	0 (0)	3.0 (0.7)	2.8 (0.9)
range			1.6–4.1	0.6–3.4
Length of exposure to French				
mean (SD)	–	–	4.3 (0.11)	5.1 (1.0)
range			2.8–6.9	3.9–7.3
Proportion of L1 exposure at home				
mean (SD)			77% (10)	77% (20)
range			57–95	25–100
Novel-word repetition				
mean (SD)	100 (9)	41 (21)	83 (21)	35 (24)
range	85–100	20–70	40–115	10–55
				(one outlier at 100)

Age at testing in years and months; Age of first exposure to French in years and months; Length of exposure to French at testing in years and months ; Raven = non-verbal IQ standard-scores (mean = 100; SD = 15); mother's education in years; Novel-word repetition = standard-scores (mean = 100; SD = 15)

As expected, there was a significant group effect on the novel word repetition task $F(3,64) = 43.03$, $p < .001$, $\eta_p^2 = .67$. Pairwise comparisons across groups revealed a significant difference between the TD children and their peers with SLI for both monolinguals (MOTD / MOSLI: $F(1,34) = 109.77$, $p < .001$, $\eta_p^2 = .76$), and bilinguals (BITD / BISLI: $F(1,30) = 36.39$, $p < .001$, $\eta_p^2 = .55$), confirming novel word repetition as a strong clinical marker of SLI (see above). In line with previous research (see above), a significant difference was also found between the MOTD and BITD children, $F(1,34) = 9.00$, $p = .005$, $\eta_p^2 = .21$. No significant difference was found between the MOSLI and the BISLI children, $F(1,30) = .63$, $p = .43$, $\eta_p^2 = .02$ ns. One bilingual child with SLI performed above expectations on the novel word repetition task with a standard score of 100. Excluding this outlier, however, did not affect the statistics reported on the characteristics of the population, except for age for which the significant group effect disappeared $F(3,63) = 2.41$, $p = .08$, $\eta_p^2 = .10$. Excluding this outlier did not affect the statistics reported for the results either.

2.2 Task and procedure

A classic visual stop signal task (SST) was used to assess non-verbal response inhibition. Stop signal tasks have been shown to reliably assess response inhibition (e.g., Kindlon, Mezzacappa, & Earls, 1995). The task contained 32 training trials and 192 target trials. Children were shown a succession of left or right pointing arrows on a computer screen. In case of a green arrow, children had to press as quickly as possible the left- or the right-button of the press pad according to the direction of the arrow. This corresponded to GO-trials (Figure 1). When the arrow turned red, children were instructed to restrain from pressing the button. This corresponded to STOP-trials. The color change from green to red (STOP-trials) occurred in 25% of the trials and was unpredictable. The time interval between the arrow onset and the arrow color change varied according to children's performance to ensure a success rate on 50% of the STOP-trials. A dynamic tracking algorithm was used to force a tie between GO and STOP-trials, in order to have a proper estimation of response inhibition ability (Logan *et al.* 1997). First, children went through a training session that consisted of two parts. In the first 16 training trials, children were introduced to the press pad and were shown only GO-trials. For the last 16 training trials, children were introduced to the actual SST task, being instructed to keep pressing the buttons as they just did (GO-trials), but stop pressing if the arrow turned red (STOP-trials). The test session was divided into three blocks of 64 trials. To ensure that the poor language abilities of children with SLI would not affect their EF performance, verbal instructions were simple and reinforced by visual cues (Jensen de Lopez & Baker, 2015). Visual feedback was

given in case of wrong answers during the training session. After each block, a simple graph displayed the percentages of correct inhibited responses as well as the mean reaction time. The graph was explained to the children so that they could keep track of their scores and if necessary clarify the instructions and re-mobilize their attention and motivation for the task.

Figure 1. Stop signal task: example of a GO-trial

The main dependent variable was the mean *stop stimulus reaction time* (SSRT). The mean SSRT reflects the difference between the mean RT (reaction time) on the GO-trials and the mean RT on the STOP-trials for which children succeeded in inhibiting their response. It gives an estimate of the length of time for which children are able to inhibit a pre-potent motor response. Large SSRTs indicate poor inhibition abilities. The mean proportion of correctly inhibited trials was also assessed to ensure that the dynamic tracking algorithm worked well and that participants were able to successfully inhibit their responses about half of the time. A standard procedure was followed. Following standard practice, data from the first experimental block was excluded from the analysis because participants require many trials to adjust to the task. Participants were also excluded if their proportion of correct inhibitions were below or equal to 20% or above or equal to 80% in the second or third experimental block. For these reasons, one MOTD child, two MOSLI children and two BITD children were excluded. For each participant, the first four responses of each block were excluded from the analyses, as well as responses with RTs shorter than 120 ms or different from the mean by more than two standard deviations. All incorrect responses, as well as responses that followed incorrect responses, were excluded from the RT analyses.

2.3 Statistical analyses

2.3.1 *Determining effects of SLI and bilingualism*

Data was checked for normal distribution using a Kolmogorov-Smirnov's test and for homogeneous variances using a Levene's test. Data for the mean proportion of

correctly inhibited trials was normally distributed, $D(61) = .19$, but data for the mean stop signal reaction times (SSRTs) was not, $D(61) = .02$. A non-parametric test was performed on the SSRT measures to assess whether this affected the results, but no difference between a parametric and a non-parametric test was observed. Therefore, parametric tests were used. A two-way ANOVA with SLI (SLI / TD) and bilingualism (monolinguals / bilinguals) as between-subject factors was used to determine whether there was an effect of SLI, an effect of bilingualism and an interaction between SLI and bilingualism. Effect sizes of SLI and bilingualism were reported using partial eta squares (η_p^2). An effect size of a partial eta-square for ANOVAs was considered to be small at .02, medium at .13 and large at .26 (Miles & Shevlin, 2001). We controlled for non-verbal IQ, SES and age by entering these variables as covariates. A stepwise multiple regression analysis, including SLI, bilingualism, SES, non-verbal IQ and age as potential predictors of SSRT was also performed in order to provide additional insight into the results.

2.3.2 *Evaluating diagnostic accuracy*

As mentioned earlier, sensitivity and specificity were estimated in order to assess the level of diagnostic accuracy of the stop signal task. Receiver Operator Characteristic (ROC) curves were used to identify the cut-off scores at which both sensitivity and specificity were optimal. ROC curves plot sensitivity against specificity for all possible scores through the whole range of scores. The optimum cut-off score was defined as the score combining the highest sensitivity and an acceptable level of specificity. The higher the sensitivity, the better the task is at detecting the children with a disorder. The higher the specificity, the better the task is at detecting children without the disorder. An ideal task has 100% sensitivity and 100% specificity, with all impaired children performing typically below a certain cut-off score and all unaffected children performing typically at or above this same cut-off. In fact, the more a test gains in sensitivity, the more it loses in specificity. Levels of sensitivity or specificity at 90% or higher are usually considered as indicators of good diagnostic accuracy, between 80% and 90%, fair, and below 80% poor (Greenslade, Plante, & Vance, 2009; Plante & Vance, 1994).

3. Results

3.1 Effects of SLI and bilingualism on response inhibition

As a background analysis, a two-way ANOVA with SLI and bilingualism as between-subject factors was performed on the mean proportion of correctly inhibited trials. No main effect of SLI, $F(1,57) = 0.7$, $p = .41$ ns, or bilingualism,

$F(1,57) = 1.6$, $p = .21$ ns, was observed on the proportion of correctly inhibited trials.² Participants correctly inhibited their responses on about half of the inhibition trials (Table 2), indicating that the dynamic tracking algorithm worked well for these children (see Section 2.2).

Table 2. Stop signal task: Mean percentages (standard deviations) (SD) of correctly inhibited trials and median stop signal reaction times (SD) in milliseconds (ms) per group

	MOTD	MOSLI	BITD	BISLI
Proportions of correctly inhibited trials (SD)	50 (.07)	52 (.09)	52.5 (.07)	54 (.05)
Mean SSRT: median (SD)	253 (93)	302 (114)	259 (94)	292 (58)

The SSRT was then analyzed with a two-way ANOVA with SLI and bilingualism as between- subject factors to assess the effects of both SLI and bilingualism. Results are displayed in Table 2. A significant negative effect of SLI was observed, $F(1,57) = 5.29$, $p = .02$, $\eta_p^2 = .08$.³⁴ Age, entered as a covariate, was not significantly related to inhibition performance.⁵ Controlling for non-verbal IQ or SES did not change the results. A stepwise multiple regression analysis, including SLI, bilingualism, SES, non-verbal IQ and age as potential predictors of SSRT, indicated that SLI was the best predictor (adjusted $r^2 = .097$, $F(1,57) = 7.09$, $p = .01$). SES was then selected as the second predictor leading to a more complete model (adjusted $r^2 = .165$, $F(2,57) = 6.64$, $p = .003$). No other predictors were selected. As a group, children with SLI showed a longer reaction time ($M = 305$ ms) than TD peers ($M = 250$ ms), indicating that they were overall less efficient at actively suppressing a habitual response. However, as indicated by the small effect size, considerable inter-individual variation, as well as the presence of outliers, were observed in the current study, indicating that children with SLI were not necessarily performing badly and that TD children were not necessarily performing well.

2. Excluding the BISLI child who performed above expectations on novel word repetition (see Section 2.1) did not affect the results: the effects of SLI ($F(1,56) = .82$, $p = .37$, $\eta_p^2 = .01$) and bilingualism ($F(1,56) = 1.78$, $p = .19$, $\eta_p^2 = .03$) remained non-significant.

3. Because data was not normally distributed (see Section 2.3.1), a non-parametric Mann-Whitney test was also performed. This yielded a significant effect of SLI, $U = 613$, $z = 2.15$, $p = .03$, $r = 0.27$.

4. Excluding the BISLI child who performed above expectations on novel word repetition (see Section 2.1) did not affect the results: the effect of SLI remained significant, $F(1,56) = 4.69$, $p = .03$, $\eta_p^2 = .08$.

5. Covarying age created an artifact indicating that performance in inhibition decreased with age. This artifact reflects the confound between age and SLI in the data, with the oldest children being SLI.

With regard to bilingualism, no significant effect was observed, $F(1,57) = 0.68$, $p = .41$, $\eta_p^2 = .01$, ns.⁶⁷ Controlling for age, non-verbal IQ or SES did not change the results. Bilinguals did not show enhanced response inhibition abilities compared to monolingual peers. No interaction between SLI and bilingualism was observed either, $F(1,57) = 0.55$, $p = .46$, $\eta_p^2 = .01$ ns. There was no difference in the impact of SLI on response inhibition between bilinguals and monolinguals.

3.2 Diagnostic accuracy

While a SLI effect was observed at the group level, it was necessary to evaluate whether these results were mirrored at the individual level and whether the stop signal task could thus be an adequate measure for classifying a child as having SLI or not. To verify this, diagnostic accuracy was estimated for the task on the basis of the SSRT scores. Given the large individual variation in SSRT scores observed within some groups, we did not necessarily expect response inhibition to appropriately classify children with and without SLI. In order to estimate the diagnostic value of the stop signal task, sensitivity and specificity were examined (Section 2.3.2). We did not expect diagnostic accuracy to differ between monolinguals and bilinguals, since bilinguals did not significantly differ in performance from their monolingual peers (Section 3.1). We therefore estimated diagnostic accuracy, *not* taking into account bilingualism. Using ROC curves, a SSRT score of 261 ms was identified as the cut-off score that best differentiated between children with and without SLI (Section 2.3.2). Eight of the 29 children with SLI had a SSRT at or above 261 ms, compared to 18 of the 32 TD children. Taking this cut-off led to low levels of sensitivity and specificity of 72 and 56 respectively (Section 2.3.2), indicating that this task is not reliable to rule in or rule out SLI. Overall, results suggested that response inhibition cannot be considered as a clinical marker of SLI. Given the results at the group level (Section 3.1), children with SLI seemed more at risk than their TD peers for poor performance in response inhibition, as measured by the stop signal task. Nevertheless, this finding was not matched by sufficient diagnostic accuracy.

6. Because data was not normally distributed (see Section 2.3.1), a non-parametric Mann-Whitney test was performed. This also yielded a non-significant effect of SLI, $U = 425$, $z = -.56$, $p = .57$, $r = -0.07$.

7. Excluding the BISLI child who performed above expectations on novel word repetition (see Section 2.1) did not affect the results: the effect of bilingualism remained non-significant, $F(1,56) = .83$, $p = .37$, $\eta_p^2 = .01$.

4. Discussion and conclusion

The main aim of the present study was to estimate the extent to which a non-verbal task tapping response inhibition can clinically contribute to the diagnosis of SLI, specifically in successive bilingual children for whom the diagnosis of SLI is problematic if done on the basis of language measures only. Using a four-group design including monolingual and bilingual children with and without SLI, this study made it possible to examine both the effect of bilingualism and the effect of SLI on response inhibition within the same population. We used a visual stop signal task, a task that has been proven reliable for the measure of response inhibition (e.g., Kindlon *et al.*, 1995).

With regard to the effects of bilingualism and SLI on response inhibition, results were in line with our predictions. No effect of bilingualism was found confirming previous findings (Bonifaci *et al.*, 2011; Carlson & Meltzoff, 2008; Luk *et al.*, 2010; Martin-Rhee & Bialystok, 2008). This result suggested that response inhibition is a promising measure to assess the effect of SLI, independently of bilingualism. Further, a significant effect of SLI was observed, with children with SLI exhibiting poorer performance in response inhibition than their TD peers. The SLI children in the present study had been screened for ADHD, a developmental disorder in which response inhibition is impaired (Pennington & Ozonoff, 1996), so that their inhibition deficit could not be attributed to ADHD comorbidity (Section 2.1). Similarly, controlling for SES and non-verbal IQ yielded the same difference between SLI and TD children, indicating that these two factors could not account for poor response inhibition in children with SLI either. These results were in line with the majority of previous studies that had reported a deficit in SLI for response inhibition, when tested either verbally (Bishop & Norbury, 2005; Marton *et al.*, 2007; Roello *et al.*, 2015; Spaulding, 2010) or non-verbally (Bishop & Norbury, 2005; Henry *et al.*, 2012; Im-bolter *et al.*, 2006). However, our findings contradict a few other studies (Marton *et al.*, 2012; Noterdaeme *et al.*, 2001). Marton *et al.* (2012) had used a similar stop signal task to the one used in our study but did not find a poorer performance in children with SLI. A major difference between the two studies, however, lies in the age of the participants, with the children of the present study being four years and a half younger (M: 7 years and 5 months) than the children in Marton *et al.*'s study (2012) (M: 12 years and 4 months). The difference in performance between TD and SLI children may reduce with age as a result of a different maturational trajectory of the inhibition processes in children with SLI, and thus no longer be visible in the age group tested by Marton *et al.* As mentioned earlier, inhibition develops slowly as a result of the slow maturation of the pre-frontal cortex during childhood and through adolescence (Huizinga *et al.*, 2006; Klenberg *et al.*, 2001). Children with SLI might

therefore have a maturational delay in inhibition processes that gradually resolves itself. Recent results support this hypothesis (Epstein *et al.*, 2014) (see Section 1.1).

With respect to the clinical contribution of response inhibition to the diagnosis of SLI, an important finding from our study is that a stop signal task does not appear accurate in diagnosing SLI in monolingual and bilingual children aged 6 to 8. Even though a significant effect of SLI was observed at the group level, performance on this task could not clearly distinguish between children with and without SLI at the individual level. Levels of sensitivity and specificity of the task were low. Our results disappointingly indicate that response inhibition cannot reliably contribute to the diagnosis of SLI in either a monolingual or bilingual context. This finding adds an important dimension to studies that found group differences, but failed to measure diagnostic accuracy.

Our results confirmed some earlier results that children with SLI as a group perform significantly more poorly than TD peers. This suggests an association between the deficit in response inhibition and language in SLI, but there are different ways of viewing this association. One explanation might be that there is a direct relationship between the language deficits of children with SLI and their deficit in response inhibition. For example, the use of inner speech might help performance in inhibiting a response, because the instruction would be reactivated verbally while performing the inhibition task (Russell, Jarrold, & Hood, 1999). The poor inner language of SLI children would therefore lead to poor inhibition control. In contrast, poor skills in response inhibition might *cause* language deficits. Proponents of the processing accounts of SLI have actually argued that the language deficits observed in children with SLI are caused by some general limitations in processing information (Bishop, 1992, 1994; Joanisse & Steinberg, 1998, 2003; Kail, 1994; Leonard, 2014; Montgomery, 2000; Montgomery *et al.*, 2010; see Section 1.1). More recently, some authors have proposed that these processing limitations could be operationalized more specifically in terms of deficits in one or more EFs, that is in one or more of these specific cognitive operations needed during information processing (Epstein *et al.*, 2014; Henry *et al.*, 2012; Im-bolter *et al.*, 2006; Spaulding, 2010). Inhibition is one of these cognitive operations. Response inhibition in particular might play a critical role in language production by assisting the retrieval and the activation of a relevant linguistic element that might potentially conflict with other, no longer relevant, linguistic elements. For example, poor response inhibition might explain the difficulty of children with SLI in word retrieving (McGregor *et al.*, 2002; Messer & Dockrell, 2006) due to the competition between the target relevant word and other potentially conflicting words that are not relevant but still active in semantic representations. Recent findings support this hypothesis (Epstein *et al.*, 2014). Similarly, poor response inhibition might account for the difficulty of children with SLI in producing

an appropriate, but less overlearned, syntactic structure. For example, English-speaking children with SLI have problems producing the third person singular -s in present tense and produce the infinitival form instead (Rice & Wexler, 1996). One plausible explanation might be that the under-representation of the -s ending compared to the over-represented infinitival form in the English verbal paradigm (Theakston, Lieven, & Tomasello, 2003) might cause children to fail to inhibit the high-frequency morphological form, that is the infinitival form, when they would need to activate the relevant, but low-frequency -s ending.

One limitation of our study is that response inhibition was assessed with one task only. Previous research has demonstrated that EF ideally needs to be measured using multiple tasks, in order to control for random and systematic errors and to control for the manifestation of possible other EF processes that inevitably operate in combination with the target EF process (Miyake *et al*, 2000). Another limitation is that only response inhibition was assessed. It could also be the case that other non-verbal EF tasks would be more strongly accurate in diagnosing SLI in both monolingual and bilingual contexts. To date, research on non-verbal EF in children with SLI remains scarce and leads to conflicting results, due to the heterogeneity of the studies, in terms of ages of the participants, EF tasks used or diagnostic criteria (Elin Thordardottir, 2015; Kapa & Plante, 2015). Finally, our stepwise regression analysis suggested that SES might be a secondary predicting factor of inhibition performance. Nevertheless, since our research was not originally designed to assess the effect of SES, it seems premature to draw any firm conclusion from our experimental results on the contribution of SES to response inhibition. Further research should take these different aspects into account in order to better understand the EF deficits observed in the population with SLI.

These results on diagnostic accuracy nevertheless cast doubt on the idea that the language deficits of individuals with SLI strongly relate to their non-verbal deficits, in the domain of response inhibition at least. It might be thought that only the SLI children with the most severe language impairment exhibit deficits in response inhibition. However our results go against this assumption, since children with SLI in the current study were likely to have more severe language deficits than in other studies as the traditional cut-off used for the diagnosis of SLI in France is stricter than in other countries (Section 2.1).

Nevertheless there is variation in any SLI group related to the severity of the impairment. It will therefore be useful in future research to use performance on general language measures as an indication of the severity of the impairment and to consider this as a variable in assessment. Previous research has indeed shown that language proficiency might display a relationship with some executive functions in bilingual TD children (e.g., Iluz-Cohen & Armon-Lotem, 2013). Relating performance on response inhibition to performance on general language measures

might therefore provide a more comprehensive picture of the relationship between language and response inhibition in children with SLI. Unfortunately, assessing such relationship was not possible in the current study since the language of bilingual children, either TD or SLI, could not be fully assessed because of the impossibility of testing their L1 (see Section 2.1).

Our current results suggest that performance on response inhibition does not strongly predict performance in language. Instead, deficits in these two aspects of behaviour might merely co-occur in SLI, without there being necessarily a relation of causality between the two. This interpretation should of course be taken with caution, given the small samples involved here. Furthermore, it might be the case that the link between response inhibition and language becomes less strong with age. We have argued that response inhibition might become less problematic with age for children with SLI compared to TD peers. Response inhibition might in turn be more accurate in diagnosing SLI in younger children. In order to better understand the developmental trajectory of response inhibition in children with SLI and its clinical use at different ages, further research is needed.

Our study is one of the first studies to estimate the accuracy of a non-verbal EF task in identifying children with and without SLI. By doing this, we showed that, to better understand the nature of the EF deficit in SLI, it is necessary to go beyond the assessment of an SLI group effect, and investigate the extent to which the EF deficit observed in the individual children with SLI can account for their diagnosis of SLI.

References

- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders, 4th ed. (DSM-IV)*. Washington, DC: American Psychiatric Association.
- Baddeley, A. D. (2003). Working memory and language: An overview. *Journal of Communication Disorders*, 36(3), 189–208. doi: 10.1016/S0021-9924(03)00019-4
- Baddeley, A. D., & Hitch, G. (1974). Working memory. *Psychology of Learning and Motivation*, 8, 47–89. doi: 10.1016/S0079-7421(08)60452-1
- Bialystok, E. (1999). Cognitive complexity and attentional control in the bilingual mind. *Child Development*, 70(3), 636–644. doi: 10.1111/1467-8624.00046
- Bialystok, E. (2001). *Bilingualism in development: Language, literacy, and cognition*. Cambridge: Cambridge University Press. doi: 10.1017/CBO9780511605963
- Bialystok, E. (2006). Effect of bilingualism and computer video game experience on the Simon task. *Canadian Journal of Experimental Psychology/Revue Canadienne de Psychologie Expérimentale*, 60(1), 68. doi: 10.1037/cjep2006008
- Bialystok, E., Craik, F. I., Grady, C., Chau, W., Ishii, R., Gunji, A., & Pantev, C. (2005). Effect of bilingualism on cognitive control in the Simon task: Evidence from MEG. *NeuroImage*, 24(1), 40–49. doi: 10.1016/j.neuroimage.2004.09.044

- Bialystok, E., Craik, F. I., Klein, R., & Viswanathan, M. (2004). Bilingualism, aging, and cognitive control: evidence from the Simon task. *Psychology and aging*, 19(2), 290. doi: 10.1037/0882-7974.19.2.290
- Bialystok, E., & Viswanathan, M. (2009). Components of executive control with advantages for bilingual children in two cultures. *Cognition*, 112(3), 494–500. doi: 10.1016/j.cognition.2009.06.014
- Bishop, D. V. M. (1992). The underlying nature of specific language impairment. *Journal of Child Psychology and Psychiatry*, 33(1), 3–66. doi: 10.1111/j.1469-7610.1992.tb00858.x
- Bishop, D. V. M. (1994). Grammatical errors in specific language impairment: Competence or performance limitations?. *Applied Psycholinguistics*, 15(4), 507–550. doi: 10.1017/S0142716400006895
- Bishop, D. V. M., & Norbury, C. F. (2005). Executive functions in children with communication impairments, in relation to autistic symptomatology I: Generativity. *Autism*, 9(1), 7–27. doi: 10.1177/1362361305049027
- Bishop, D. V. M. (2014). Ten questions about terminology for children with unexplained language problems. *International Journal of Language and Communication Disorders*, 49(4), 381–415. doi: 10.1111/1460-6984.12101
- Blasi, G., Goldberg, T. E., Weickert, T., Das, S., Kohn, P., Zolnick, B., Bertolino, A., Callicott, J. H., Weinberger, D. R., & Mattay, V. S. (2006). Brain regions underlying response inhibition and interference monitoring and suppression. *European Journal of Neuroscience*, 23(6), 1658–1664. doi: 10.1111/j.1460-9568.2006.04680.x
- Bonifacci, P., Giombini, L., Bellocchi, S., & Contento, S. (2011). Speed of processing, anticipation, inhibition and working memory in bilinguals. *Developmental Science*, 14(2), 256–269. doi: 10.1111/j.1467-7687.2010.00974.x
- Bunge, S. A., Dudukovic, N. M., Thomason, M. E., Vaidya, C. J., & Gabrieli, J. D. (2002). Immature frontal lobe contributions to cognitive control in children: Evidence from fMRI. *Neuron*, 33(2), 301–311. doi: 10.1016/S0896-6273(01)00583-9
- Cardy, J. E. O., Tannock, R., Johnson, A. M., & Johnson, C. J. (2010). The contribution of processing impairments to SLI: Insights from attention-deficit/hyperactivity disorder. *Journal of Communication Disorders*, 43(2), 77–91. doi: 10.1016/j.jcomdis.2009.09.003
- Carlson, S. M., & Meltzoff, A. N. (2008). Bilingual experience and executive functioning in young children. *Developmental Science*, 11(2), 282–298. doi: 10.1111/j.1467-7687.2008.00675.x
- Chapman, R. S. (1997). Language development in children and adolescents with Down syndrome. *Mental Retardation and Developmental Disabilities Research Reviews*, 3(4), 307–312. doi: 10.1002/(SICI)1098-2779(1997)3:4<307::AID-MRDD5>3.0.CO;2-K
- Chevrie-Muller, C., & Plaza, M. (2001). *N-EEL: Nouvelles épreuves pour l'examen du langage* [New tasks for the assessment of language]. Paris: Éditions du Centre de Psychologie Appliquée (ECPA).
- Conti-Ramsden, G., Botting, N., & Faragher, B. (2001). Psycholinguistic markers for specific language impairment (SLI). *Journal of Child Psychology and Psychiatry*, 42(6), 741–748. doi: 10.1111/1469-7610.00770
- Costa, A., Hernández, M., & Sebastián-Gallés, N. (2008). Bilingualism aids conflict resolution: Evidence from the ANT task. *Cognition*, 106(1), 59–86. doi: 10.1016/j.cognition.2006.12.013
- Crago, M., & Paradis, J. (2003). Two of a kind? Commonalities and variation in languages and language learners. In Y. Levy & J. Schaeffer (Eds.), *Language competence across populations: Towards a definition of specific language impairment* (pp.97–110). Mahwah, NJ: Erlbaum.

- Crutchley, A. (1999). Bilingual children with SLI attending language units: getting the bigger picture. *Child Language Teaching and Therapy*, 15(3), 201–217.
doi: 10.1191/026565999672131522
- Diamond, A. (2002). Normal development of prefrontal cortex from birth to young adulthood: Cognitive functions, anatomy, and biochemistry. In D. T. Stuss & R. T. Knight (Eds.), *Principals of frontal lobe function* (pp.466–503). London: Oxford University Press.
doi: 10.1093/acprof:oso/9780195134971.003.0029
- De Bruin, A., Treccani, B., & Della Sala, S. (2014). Cognitive advantage in bilingualism: An example of publication bias? *Psychological Science*, 26(1), 99–107.
doi: 10.1177/0956797614557866
- Deltour, J. J. (1992). *Test de closure grammaticale (TCG)* [Test of grammatical closure (TCG)]. Liège: Presse Universitaire de Liège.
- Deltour, J. J., & Hupkens, D. (1980). *TVAP, Test de vocabulaire actif et passif* [TVAP, Test of active and passive vocabulary]. Paris: Editions EAP.
- Dollaghan, C., & Campbell, T. F. (1998). Nonword repetition and child language impairment. *Journal of Speech, Language, and Hearing Research*, 41(5), 1136–1146.
doi: 10.1044/jslhr.4105.1136
- Dunn, L. M., Thériault-Whalen, C. M., & Dunn, L. M. (1993). *Echelle de vocabulaire en images peabody: Adaptation française du Peabody Picture Vocabulary Test* [Scale of vocabulary using peabody pictures : French adaptation of the peabody picture vocabulary test]. Toronto, Canada: Psycan.
- Elin Thordardottir, E. T. (2015). Proposed diagnostic procedures for use in bilingual and cross-linguistic contexts. In S. Armon-Lotem, J. de Jong, & N. Meir (Eds.), *Methods for assessing multilingual children: Disentangling bilingualism from Specific Language Impairment* (pp.331–358). Bristol: Multilingual Matters.
- Elin Thordardottir, E. T., & Brandeker, M. (2013). The effect of bilingual exposure versus language impairment on nonword repetition and sentence imitation scores. *Journal of Communication Disorders*, 46(1), 1–16. doi: 10.1016/j.jcomdis.2012.08.002
- Engel de Abreu, P. M. E., Cruz-Santos, A., Tourinho, C. J., Martin, R., & Bialystok, E. (2012). Bilingualism enriches the poor enhanced cognitive control in low-income minority children. *Psychological Science*, 23(11), 1364–1371. doi: 10.1177/0956797612443836
- Engel de Abreu, P.M.E., Cruz-Santos, A., & Puglisi, M. (2014). Specific language impairment in language-minority children from low-income families. *International Journal of Language & Communication Disorders*, 49(6), 736–747. doi: 10.1111/1460-6984.12107
- Epstein, B., Shafer, V. L., Melara, R. D., & Schwartz, R. G. (2014). Can children with SLI detect cognitive conflict? Behavioral and electrophysiological evidence. *Journal of Speech, Language, and Hearing Research*, 57(4), 1453–1467. doi: 10.1044/2014_JSLHR-L-13-0234
- Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: a latent-variable analysis. *Journal of Experimental Psychology: General*, 133(1), 101. doi: 10.1037/0096-3445.133.1.101
- Greenslade, K. J., Plante, E., & Vance, R. (2009). The diagnostic accuracy and construct validity of the Structured Photographic Expressive Language Test Preschool. *Language, Speech, and Hearing Services in Schools*, 40(2), 150–160. doi: 10.1044/0161-1461(2008/07-0049)
- Grüter, T. (2005). Comprehension and production of French object clitics by child second language learners and children with specific language impairment. *Applied Psycholinguistics*, 26(3), 363–91. doi: 10.1017/S0142716405050216

- Henry, L. A., Messer, D. J., & Nash, G. (2012). Executive functioning in children with specific language impairment. *Journal of Child Psychology and Psychiatry*, 53(1), 37–45.
doi: 10.1111/j.1469-7610.2011.02430.x
- Hoff, E. (2006). How social contexts support and shape language development. *Developmental Review*, 26(1), 55–88. doi: 10.1016/j.dr.2005.11.002
- Hoffman, L. M., & Gillam, R. B. (2004). Verbal and spatial information processing constraints in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 47(1), 114–125. doi: 10.1044/1092-4388(2004/011)
- Huizinga, M., Dolan, C. V., & Van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia*, 44(11), 2017–2036. doi: 10.1016/j.neuropsychologia.2006.01.010
- Illuz-Cohen, P., & Armon-Lotem, S. (2013). Language proficiency and executive control in bilingual children. *Bilingualism: Language and Cognition*, 16(4), 884–899.
doi: 10.1017/S1366728912000788
- Im-Bolter, N., Johnson J., and Pascual Leone, J. (2006). Processing limitations in children with SLI: The role of executive function. *Child Development*, 77(6), 1822–1841.
doi: 10.1111/j.1467-8624.2006.00976.x
- Jensen de Lopez, K. M., & Baker, A. E. (2015). Executive functions in the assessment of bilingual children with language impairment. In S. Armon-Lotem, J. de Jong, & N. Meir (Eds.), *Methods for assessing multilingual children: Disentangling bilingualism from Specific Language Impairment* (pp.277–297). Bristol: Multilingual Matters.
- Joanisse, M. F., & Seidenberg, M. S. (1998). Specific language impairment: A deficit in grammar or processing? *Trends in Cognitive Sciences*, 2(7), 240–247.
doi: 10.1016/S1364-6613(98)01186-3
- Joanisse, M. F., & Seidenberg, M. S. (2003). Phonology and syntax in specific language impairment: Evidence from a connectionist model. *Brain and Language*, 86(1), 40–56.
doi: 10.1016/S0093-934X(02)00533-3
- Kail, R. (1994). A method for studying the generalized slowing hypothesis in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 37(2), 418–421. doi: 10.1044/jshr.3702.418
- Kapa, L. L., & Plante, E. (2015). Executive Function in SLI: Recent Advances and Future Directions. *Current Developmental Disorders Reports*, 2(3), 245–252.
doi: 10.1007/s40474-015-0050-x
- Kaufman, A. S., & Kaufman, N. L. (2004). *K-ABC-II. Kaufman Assessment Battery for Children. Second edition. Manual*. Circle Pines, MN: American Guidance Service.
- Khoms, A. (2000). *Évaluation du langage oral: ELO* [Assessment of spoken language : ELO]. Paris: Éditions du Centre de Psychologie Appliquée (ECPA).
- Klenberg, L., Korkman, M., & Lahti-Nuuttila, P. (2001). Differential development of attention and executive functions in 3- to 12-year-old Finnish children. *Developmental Neuropsychology*, 20(1), 407–428. doi: 10.1207/S15326942DN2001_6
- Kohnert, K. (2010). Bilingual children with primary language impairment: Issues, evidence and implications for clinical actions. *Journal of Communication Disorders*, 43(6), 456–473.
doi: 10.1016/j.jcomdis.2010.02.002
- Kohnert, K., Windsor, J., & Yim, D. (2006). Do language-based processing tasks separate children with language impairment from typical bilinguals? *Learning Disabilities: Research & Practice*, 21(1), 19–29.

- Kindlon, D., Mezzacappa, E., & Earls, F. (1995). Psychometric properties of impulsivity measures: Temporal stability, validity and factor structure. *Journal of Child Psychology and Psychiatry*, 36, 645–661. doi: 10.1111/j.1469-7610.1995.tb02319.x
- Kroll, J. F., & Dijkstra, A. (2002). The bilingual lexicon. In R. Kaplan (Ed.), *Handbook of Applied Linguistics* (pp. 301–321). Oxford, England: Oxford University Press.
- Lakshmanan, U. (2012). Child second language acquisition. In P. Robinson (Ed.), *The Routledge Encyclopedia of Second Language Acquisition* (pp.71–75). London: Routledge.
- Lecocq, P. (1996). *L'ÉCOSSE, une épreuve de compréhension syntaxico-sémantique : Adaptation française du Test of Reception of Grammar (TROG)* [The ECOSSE, a task of syntactic and semantic understanding : French adaptation of the Test of Reception of Grammar (TROG)]. Paris: Presses Universitaires Septentrion.
- Leonard, L. B. (2014). *Children with specific language impairment. Second edition*. Cambridge: MIT press.
- Logan, G. D., Schachar, R. J., & Tannock, R. (1997). Impulsivity and inhibitory control. *Psychological Science*, 8(1), 60–64. doi: 10.1111/j.1467-9280.1997.tb00545.x
- Luk, G., Anderson, J. A., Craik, F. I., Grady, C., & Bialystok, E. (2010). Distinct neural correlates for two types of inhibition in bilinguals: Response inhibition versus interference suppression. *Brain and Cognition*, 74(3), 347–357. doi: 10.1016/j.bandc.2010.09.004
- Martin-Rhee, M. M., & Bialystok, E. (2008). The development of two types of inhibitory control in monolingual and bilingual children. *Bilingualism: Language and Cognition*, 11(1), 81–93. doi: 10.1017/S1366728907003227
- Marton, K., Kelmenson, L., & Pinkhasova, M. (2007). Inhibition control and working memory capacity in children with SLI. *Psikholgyah: ketav'et mada'i Yisre'eli le-'iyun ule-mehkar*, 50(2), 110.
- Marton, K., Campanelli, L., Scheuer, J., Yoon, J., & Eichorn, N. (2012). Executive function profiles in children with and without specific language impairment. *Rivista di psicolinguistica applicata*, 12(3), 57.
- McGregor, K. K., Newman, R. M., Reilly, R. M., & Capone, N. C. (2002). Semantic representation and naming in children with specific language impairment. *Journal of Speech, Language & Hearing Research*, 45(5), 998–1014. doi: 10.1044/1092-4388(2002/081)
- Messer, D., & Dockrell, J. E. (2006). Children's naming and word-finding difficulties: Descriptions and explanations. *Journal of Speech, Language, and Hearing Research*, 49(2), 309–324. doi: 10.1044/1092-4388(2006/025)
- Messer, M. H., Leseman, P. P., Boom, J., & Mayo, A. Y. (2010). Phonotactic probability effect in nonword recall and its relationship with vocabulary in monolingual and bilingual preschoolers. *Journal of Experimental Child Psychology*, 105(4), 306–323. doi: 10.1016/j.jecp.2009.12.006
- Mezzacappa, E. (2004). Alerting, orienting, and executive attention: Developmental properties and sociodemographic correlates in an epidemiological sample of young, urban children. *Child Development*, 75(5), 1373–1386. doi: 10.1111/j.1467-8624.2004.00746.x
- Miles, J., & Shevlin, M. (2001). *Applying regression and correlation: A guide for students and researchers*. London: Sage.
- Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions four general conclusions. *Current Directions in Psychological Science*, 21(1), 8–14. doi: 10.1177/0963721411429458
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal

- lobe” tasks: A latent variable analysis. *Cognitive Psychology*, 41(1), 49–100.
doi: 10.1006/cogp.1999.0734
- Montgomery, J. W. (2000). Verbal working memory and sentence comprehension in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 43(2), 293–308. doi: 10.1044/jslhr.4302.293
- Montgomery, J. W., Magimairaj, B. M., & Finney, M. C. (2010). Working memory and specific language impairment: An update on the relation and perspectives on assessment and treatment. *American Journal of Speech-Language Pathology*, 19(1), 78–94.
doi: 10.1044/1058-0360(2009/09-0028)
- Nigg, J. T. (2000). On inhibition/disinhibition in developmental psychopathology: views from cognitive and personality psychology and a working inhibition taxonomy. *Psychological bulletin*, 126(2), 220. doi: 10.1037/0033-2909.126.2.220
- Noterdaeme, M., Amorosa, H., Mildenerger, K., Sitter, S., & Minow, F. (2001). Evaluation of attention problems in children with autism and children with a specific language disorder. *European Child & Adolescent Psychiatry*, 10(1), 58–66. doi: 10.1007/s000780170048
- Paradis, J. (2004). The relevance of specific language impairment in understanding the role of transfer in second language acquisition. *Applied Psycholinguistics*, 25(1), 67–82.
doi: 10.1017/S0142716404001043
- Paradis, J. (2011). Individual differences in child English second language acquisition: Comparing child-internal and child-external factors. *Linguistic Approaches to Bilingualism*, 1(3), 213–237. doi: 10.1075/lab.1.3.01par
- Paradis, J., & Crago, M. (2000). Tense and temporality: Similarities and differences between language-impaired and second-language children. *Journal of Speech, Language, and Hearing Research*, 43(4), 834–848. doi: 10.1044/jslhr.4304.834
- Paradis, J., & Crago, M. (2004). Comparing L2 and SLI grammars in child French: Focus on DP. In P. Prévost & J. Paradis (Eds.), *The acquisition of French in different contexts: Focus on functional categories* (pp.89–107). Amsterdam: John Benjamins. doi: 10.1075/lald.32.06par
- Paradis, J., Rice, M. L., Crago, M., & Marquis, J. (2008). The acquisition of tense in English: Distinguishing child second language from first language and specific language impairment. *Applied Psycholinguistics*, 29(4), 689–722. doi: 10.1017/S0142716408080296
- Pearson, B. Z., Fernandez, S. C., Lewedeg, V., & Oller, D. K. (1997). The relation of input factors to lexical learning by bilingual infants. *Applied Psycholinguistics*, 18(1), 41–58.
doi: 10.1017/S0142716400009863
- Pennington, B. F., & Ozonoff, S. (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry*, 37(1), 51–87.
doi: 10.1111/j.1469-7610.1996.tb01380.x
- Pierart, B., Comblain, A., Grégoire, J., Mousty, P., & Noël, M. P. (1997). ISADYLE: Instrument pour le screening et l'examen approfondi des dysfonctionnements du langage chez l'enfant [ISADYLE : Instrument for the screening and the in-depth assesment of child language dysfunctions]. In *Meeting annuel de la Société Belge de Psychologie*.
- Plante, E., & Vance, R. (1994). Selection of preschool language tests: A data-based approach. *Language, Speech, and Hearing Services in Schools*, 25(1), 15–24.
doi: 10.1044/0161-1461.2501.15
- Raven, J. C., Court, J. H., & Raven, J. (1985). *Raven's progressive matrices. A manual for Raven's Progressive Matrices and Vocabulary Scales*. London: H. K. Lewis.

- Roello, M., Ferretti, M. L., Colonnello, V., & Levi, G. (2015). When words lead to solutions: Executive function deficits in preschool children with specific language impairment. *Research in Developmental Disabilities*, 37, 216–222. doi: 10.1016/j.ridd.2014.11.017
- Rowe, J., Lavender, A., & Turk, V. (2006). Cognitive executive function in Down's syndrome. *British Journal of Clinical Psychology*, 45(1), 5–17. doi: 10.1348/014466505X29594
- Rice, M. L., & Wexler, K. (1996). A phenotype of specific language impairment: Extended optional infinitives. In M. L. Rice (Ed.), *Toward a genetics of language* (pp.215–237). Mahwah, NJ: Erlbaum.
- Russell, J., Jarrold, C., & Hood, B. (1999). Two intact executive capacities in children with autism: Implications for the core executive dysfunctions in the disorder. *Journal of Autism and Developmental Disorders*, 29(2), 103–112. doi: 10.1023/A:1023084425406
- Schwartz, R. G. (2009). Specific language impairment. In R.G. Schwartz (Ed.), *Handbook of Child Language Disorders* (pp.3–43). New York: Psychology Press.
- Spaulding, T. J. (2010). Investigating mechanisms of suppression in preschool children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 53(3), 725–738. doi: 10.1044/1092-4388(2009/09-0041)
- Tannock, R., & Schachar, R. (1996). Executive dysfunction as an underlying mechanism of behavior and language problems in attention deficit hyperactivity disorder. In J. H. Beitchman, N. J. Cohen, M. M. Konstantareas & R. Tannock (Eds.), *Language, learning and behavioral disorders. Developmental, biological and clinical perspectives* (pp.128–155). Cambridge: Cambridge University Press.
- Theakston, A. L., Lieven, E. V., & Tomasello, M. (2003). The role of the input in the acquisition of third person singular verbs in English. *Journal of Speech, Language, and Hearing Research*, 46(4), 863–877. doi: 10.1044/1092-4388(2003/067)
- Thorn, A. S. C., & Gathercole, S.E. (1999). Language-specific knowledge and short-term memory in bilingual and non-bilingual children. *The Quarterly Journal of Experimental Psychology*, 52(2), 303–324. doi: 10.1080/713755823
- Tomblin, J. B., Records, N. L., Buckwalter, P., Zhang, X., Smith, E., & O'Brien, M. (1997). Prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language, and Hearing Research*, 40(6), 1245–1260. doi: 10.1044/jslhr.4006.1245
- Vugs, B., Hendriks, M., Cuperus, J., & Verhoeven, L. (2014). Working memory performance and executive function behaviors in young children with SLI. *Research in Developmental Disabilities*, 35(1), 62–74. doi: 10.1016/j.ridd.2013.10.022
- Wechsler, D. (1989). Wechsler preschool and primary scales of intelligence. New York, NY: The Psychological Corporation.
- Wilson, S. P., & Kipp, K. (1998). The development of efficient inhibition: Evidence from directed-forgetting tasks. *Developmental Review*, 18(1), 86–123. doi: 10.1006/drev.1997.0445
- Windsor, J., Kohnert, K., Lobitz, K. F., Pham, G. T. (2010). Cross-language non-word repetition by bilingual and monolingual children. *American Journal of Speech- Language Pathology*, 19(4), 298–310. doi: 10.1044/1058-0360(2010/09-0064)
- World Health Organization. (1993). *The ICD-10 classification for mental and behavioral disorders: Diagnostic criteria for research*. Geneva: WHO.

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