# Potential Phonological Markers for SLI in Bilingual Children

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## 1 Introduction

Children with specific language impairment (SLI) are especially sensitive to phonological complexity. A particular deficit on consonants is reported in the literature (Gallon et al., 2007, for consonant clusters, Tamburelli & Jones, 2013, for coda position). These difficulties can cause reduction of consonant clusters resulting in a simple CV syllables as in (1a), in production of an epenthetic vowel in order to break the cluster as in (1b) (Marshall et al., 2002, Marshall et al., 2003):

(1) a. /drɛpəri/ → /dɛpəri/ b. /fɪmpələ/ →/fɪmɪpələ/
(nonword) (nonword)

Productions of children with SLI can be analyzed as difficulties with consonantal assignment to syllable structure (Ferré et al. 2012, Ferré 2013): they would have difficulties in associating certain phonemes with specific syllabic positions, and the coda appears to be especially affected. Indeed, they tend to omit sonorants such as /r/ in branching onsets, as in example (2a) and to move, as in (2b) or substitute, as in (2c, d (Orsolini et al. 2001)) the internal coda when it is a sonorant.

(2) a. /kapra/→/kapa/ b. /part/→/patr/ c. /part/→/paːt/ d. /pɔrta/ → /pɔtta/
(nonword) (nonword) (nonword) ‘door’

From a phonological perspective, branching onsets and codas are more complex than simple heads of onset (Maddieson 2006, Ferré et al. 2013, a.o.).

It is also well-known that children with SLI have difficulties with working memory (Thordardottir & Brandeker 2013, Archibald & Gathercole 2006, a.o.) However, Gallon (2002) showed that children with SLI have more difficulties producing short items that contain a complex syllable than producing longer but simpler items. Marshall et al. (2002) also observed simplifications to CV

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syllable type in monosyllabic words. It thus seems that phonological complexity so defined could be considered as a reliable domain for the identification of SLI.

In bilingual development, a child has to acquire the structures that are specific to his/her second language (L2). The acquisition of these structures will give rise to errors in various linguistic domains: phonology, syntax and the lexicon (Grüter, 2005, Paradis, 2004, 2005, Bedore & Peña, 2008). These errors can be explained by the fact that these specific structures are often complex (Scheidnes et al. 2009, Prévost et al. 2010, Slavkov, 2011). The problem is that, as we saw before, complexity is a source of difficulties and errors in children with SLI. In other words, the productions of a child acquiring a second language could be close to those of a monolingual SLI child in that language. Several studies show that cases of misdiagnosis are frequent in children learning an L2 (Crutchley et al., 1997; Grimm & Schulz, 2014).

## 2 The NWR task: an ideal assessment tool for bilinguals?

One way to address the problem of phonological assessment in a bilingual context is to use a production task that limits lexical weight and lowers the importance of the amount of exposition to the L2 (Chiat, to appear). Nonword Repetition (NWR) tasks have a special advantage over tests using vocabulary: children have never heard nonwords before, and thus their performance should not be affected by their experience of the language or by their knowledge of words. Thus, the task used should be in principle as independent as possible of a particular language. An additional advantage is that NWR tasks appear to be resistant to the influence of exposure to the L2 in bilingual children (Thordardottir & Brandeker, 2013). It means that a NWR could be used to assess language of children with few exposure. Moreover, several studies in various languages report that performance on NWR is impaired in children with SLI (a.o. Gathercole et al., 1994). Nonword repetition thus provides a good indicator of language abilities. In sum, to assess the phonology of bilingual children, and avoid risks of misdiagnosis, the test used should be less language dependent, and it should manipulate complex phonological structures.

With this aim, we designed a nonword repetition task that meets these requirements. The originality of LITMUS-NWR-FRENCH [2] is that it contains two parts: a Language-Independant (LI) part and a Language-Dependant (LD) part. These two parts are motivated by the aim to assess the language of bilingual children. The LI part contains items built with phonemes and phonotactic properties frequently found crosslinguistically (Maddieson et al., 2011). It includes branching onsets because, from a theoretical point of view, this structure can be considered as complex due to the weight it gives to the syllable. But as it is found frequently in languages, bilingual children without

[2] LITMUS: Language Impaired Testing in Multilingual settings. This tool was built within the COST Action IS0804 (Language Impairment in a Multilingual Society: Linguistics Patterns and the Road to Assessment - http://www.bi-sli.org/).

trouble should produce branching onsets without major difficulty whereas children with SLI should have strong difficulties. Items of the LD part contains phonotactics specific to few languages (including French), i.e. /l/ and /s/ in internal and final coda positions, and /s/ in wordinitial and wordfinal consonant clusters. These structures were chosen because of their complexity but also, as we saw before, because they are reported as potential source of difficulties for children with SLI (for a detailed presentation, see Ferré & dos Santos, to appear). We then can assume that the test would allow to separate the influence of bilingualism from impairment: a weak score in LD part could be explained by bilingualism or SLI, whereas a weak score in the LI part would reveal impairment.

To avoid an adding effect of the working memory that could blur the influence of phonological complexity on performance, we limited the length of the items to three syllables (See Table 1 for a general description of the task).

**Table 1 Description of LITMUS-NWR-FRENCH**

| **Language-Independent part (LI)** | **Language-Dependant part (LD)** |
|---|---|
| 20 test items, 10 control items, | 38 test items, 3 control items, |
| Phonological properties shared by most languages | Phonological properties characteristic of French |
| Vowels : /a, i, u/<br>Consonants : /p, k, f, l/<br>Syllable types : CV, CCV, CVC# | Same phonemes plus /s/<br>Same syllables types plus #sCV, #sCCV, sC# and Cs#<br>Internal coda |
| *Examples:* klipafu, fupla, faku | *Examples:* kusp, skafu, pafuski |

With its structure in two parts, this test should work as a tool to disentangle effects of bilingualism and SLI, and could help to precise areas of complexity that could work as clinical markers of SLI even in a context of bilingualism.

Given the structure of the test, and what we already know about difficulties for children with SLI and for bilingual children with respect to the acquisition of phonology, three predictions can be made:

a. If bilingual Typically-Developing (TD) children have difficulties, it will be only in the LD part due to the presence of the specific structures of French.
b. Children with SLI (BiSLI & MoSLI) will perform worse on the whole test than TD children, but especially on the LD part, because of complex structures.
c. Children with SLI (BiSLI & MoSLI) will have difficulties producing consonants in complex syllable structures.

## 3 Participants

The participants in our study are divided in four groups of monolingual and bilingual children, aged 5;2 to 8;1, with and without specific language impairment (MoTD, BiTD, MoSLI, BiSLI)[3]. All of the children have French as a first or a second language and either English, Arabic, Portuguese or Turkish as a first language in the case of the bilinguals.

Fifteen monolingual children with SLI (MoSLI) were recruited in the neuropediatric service at the university hospital in Tours. These children all had received a diagnosis of SLI, had normal hearing and nonverbal intelligence.

The group of typically-developing monolingual children (MoTD) consists of twelve French-speaking children without any speech therapy or other difficulties. These children were recruited in ordinary schools in Tours and the surrounding region.

Bilingual TD children were recruited in ordinary schools and also in places specifically frequented by persons from these origins in France. Bilingual children with suspicion of SLI were recruited in speech and language therapists' (SLT) offices and were followed for oral language impairment. No bilingual participant was adressed by the hospital: this could be linked to the fact that impairment in bilinguals is hard to assess.

### 3.1 Assessment of bilingual children

Because the bilinguals we recruited were either sequential or successive, we needed to collect information about their bilingual background. For that, a parental questionnaire (PABIQ, Tuller, to appear) was administered to parents of bilingual children in order to assess the linguistic situation of the child in terms of exposure and use of each of his/her languages (age of onset, length and richness of exposure), and his linguistic skills. This also allowed for the evaluation of a risk factor for SLI.

As already discussed, the assessment of bilingual children can lead to misdiagnosis due to structures not having been acquired/mastered in the second language (Crutchley, Conti-Ramsden & Botting, 1997; Grimm & Schulz, 2014). For this reason, the bilingual children were administered a battery of standardized tests in their first language (L1) (CELF4-UK, Semel et al., 2006, for English, and ELO-L[4], Zebib et al., to appear, for Arabic, PALPA-P, Castro et al., 2007 and GOL-E, Sua-Kay et al. (2014) for European Portuguese, TEDIL, Topbas et al., 2008, for Turkish) and in French (N-EEL, Chevrie-Muller et al., 2001, BILO-2, Khomsi et al., 2007). Since these tests were standardized on monolingual populations, we followed the cut-off recommandations by Thordardottir (2012) for the identification of language impairment in bilingual children for applying monolingually norms to bilingual children (Table 2).

[3] These children were mostly recruited for the ANR BILAD (ANR-12-FRAL-0014-01) project, which focuses on the study of language development in bilingual children.

[4] ELO-Lebanese (Zebib et al. to appear) is, as far as we know, the only standardized battery available for Arabic. Adaptations of the Lebanese version were recorded in Algerian, Libyan, Moroccan and Tunisian.

**Table 2 Cut-off points suggested by Thordardottir (2012) for the identification of SLI in bilinguals depending on language situation of the child**

| **Assessment** | | **Cut-off in at least two linguistic domains** |
|---|---|---|
| **Monolingual** | | -1.25 SD |
| **Bilingual** | In the dominant language | -1.5 SD |
| | balanced bilingualism | -1.75 SD |
| | In the weaker language | -2.25 SD |

Nonverbal level was measured via Raven Matrices (Raven, 1998). We excluded children whose score was below the 9th percentile, which is equivalent to a standard score of 80[5]. For a detailed analysis of the recruitment procedure, see Tuller et al. (to appear).

Following these criteria, two groups of bilingual children, with and without SLI, were obtained. The group of bilingual children with SLI (BiSLI) includes 19 children, 3 L1-English children, 9 L1-Arabic children, and 7 L1-European Portuguese children. The group of typically-developing bilingual children (BiTD) is composed of 39 children: 12 English-speaking children, 19 Arabic-speaking children, 7 Portuguese-speaking children and 1 Turkish-speaking child. Table 3 gives a detailed presentation of participants.

**Table 3 Participants of the study**

| | L1 | N | Total | Mean Age (SD) | Age Range | Age of contact | Length of exposure (in months) |
|---|---|---|---|---|---|---|---|
| BiSLI | English | 3 | 19 | 7;1 (1;2) | 5;2-8;11 | 0-7;0 | 18-100 |
| | Arabic | 9 | | | | | |
| | European Portuguese | 7 | | | | | |
| BiTD | English | 12 | 39 | 6;6 (0;11) | 5;2-8;2 | 0-6;4 | 12-99 |
| | Arabic | 19 | | | | | |
| | Portuguese | 7 | | | | | |
| | Turkish | 1 | | | | | |
| MoSLI | French | 15 | 15 | 7;7 (0;9) | 6;2-8;5 | - | - |
| MoTD | French | 12 | 12 | 6;0 (0;4) | 5;4-6;3 | - | - |

[5] However, children with a score below the 9th percentile but a nonverbal IQ within norms on the WISC or on another nonverbal test were not excluded.

## 4 Results

Considering reduced sample sizes, group results were compared using a Mann-Whitney nonparametric test for independent samples. The Wilcoxon non-parametric test was used for within-group analyses. We will first compare performances of children with and without SLI at the test to see if it is discriminant, even in a context of bilingualism. Then we will look at their sensitivity to complexity, first in looking at their scores in the two parts, then in looking at the most failed consonant structures. This would allowed us to check if some structures could work as clinical markers.

### 4.1 Overall performance

On the whole task (Figure 1), children with SLI (monolingual and bilingual) performed significantly lower than TD children (BiSLI 73.2%, MoSLI 45.4%, BiTD 87.6%, MoTD 90.3%) (BiSLI/BiTD U=136, p=.0001; MoSLI/MoTD U=5 p=.000033). No significant difference between the two groups of typically-developing children was found (BiTD/MoTD U=184.5 p=0.27). However, the bilingual children with SLI had much higher scores than the monolingual children with SLI (BiSLI/MoSLI U=43.5 p=0.00059).

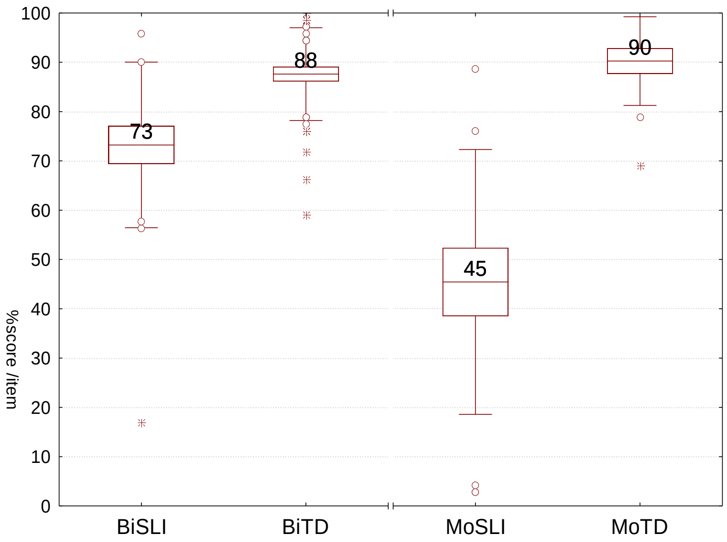


**Figure 1 Mean percentages of exact repetition on the LITMUS-NWR-FRENCH for each group of children**

Furthermore, there was almost no overlap between SLI and TD groups. This first measure suggests that, the LITMUS-NWR-FRENCH is a good indicator of SLI in bilingual children.

## 4.2 Language-Independent vs. Language-Dependent Parts

When looking at performance with the filter of linguistic specificity (Figure 2), it appears that children with SLI (bilingual and monolingual) performed significantly below TD children in the two parts (LI: BiSLI/BiTD U=173.5 p=.001, MoSLI/MoTD U=10.5 p=.00009) (LD: BiSLI/BiTD U=150.5 p=.0002, MoSLI/MoTD U=5 p=.00003). Moreover, only monolingual children with SLI showed a significant difference between the LI and LD parts of the test (z=3.18 p=.0014).

The fact that differences between SLI and TD children were not only found for the LD part of the task, but were also observed for the LI part, suggests that the phonological difficulties of the bilingual children with SLI were not solely related to the acquisition of L2 properties.

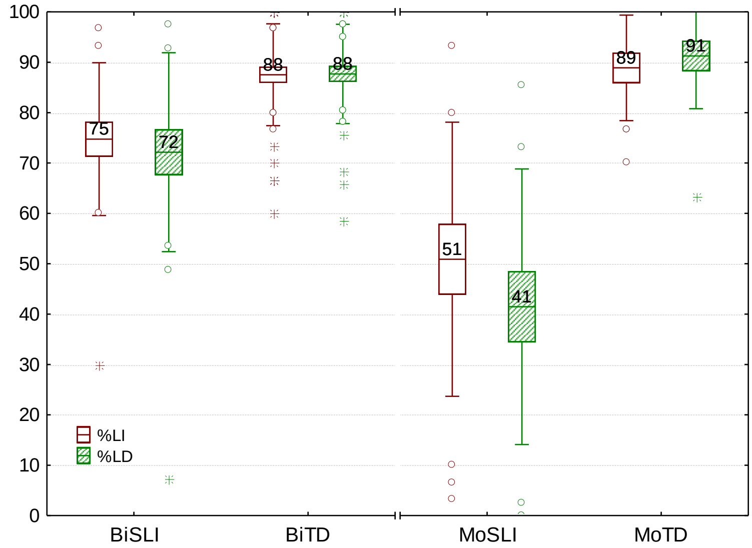


**Figure 2 Mean percentages of exact repetition on LI & LD parts of LITMUS-NWR-FRENCH for each group of children**

## 4.3 Focus on complex structures: the coda

As seen above, the litterature on SLI reports difficulties with complex syllable structure and especially with the coda. When considering liquid in internal coda position (e.g. /pi**l**.fu/) as seen in Figure 3, difficulties in each group of children with SLI were noticeable (BiSLI 60.5%, MoSLI 38.3%) whereas significant differences with TD children were found (BiTD 82.7%, MoTD 89.6%) (BiSLI/BiTD U=215 p=.0054, MoSLI/MoTD U=234.5 p=.00058).

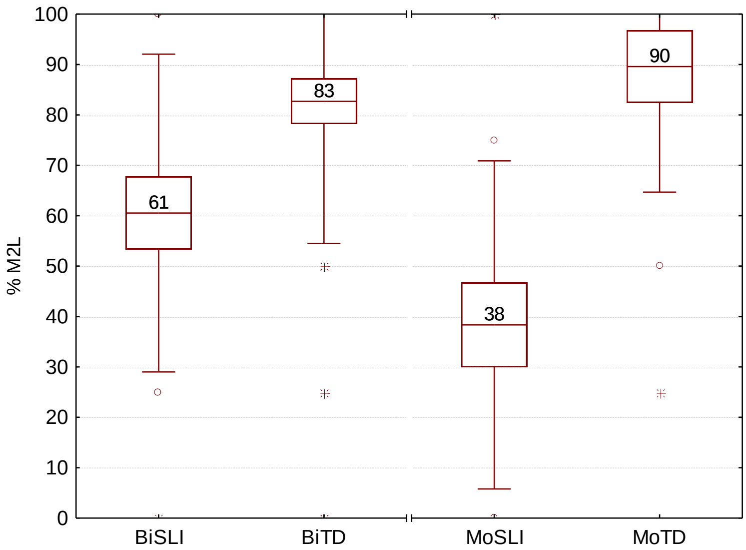


**Figure 3 Mean percentage of exact repetition on internal coda for each group of children**

Performance on this structure is apparently not related to L1 properties, since no significant difference was found between the BiTD and MoTD children (U=190 p=.24). Still, a slight difference exists between the two groups of children with SLI (BiSLI/MoSLI U=87 p=.048).

### 4.4 Focus on complexity: branching onsets

As we already saw, branching onsets constitute a source of difficulty for children with SLI. Figure 4 gives performance on branching onsets in two different positions (BO2 and BO3 are the second consonants of branching onsets in respectively a disyllabic word or a trisyllabic item, e.g. BO2: /p**l**ifu/, /kuf**l**api/, BO3: /k**l**ipafu/) besides scores on internal coda. When looking at inter-group differences, the BiTD group performed similarly to the MoTD group in producing branching onsets (BO2 U=212.5 p=.56, BO3 U=180 p=.069). But the difference is not significant for one of the two structures (BO3) when BiTD are compared to BiSLI group (BO2 U=195 p=.0013, BO3 U=369 p=.97). Indeed, BO3 structure is well produced by BiSLI children (84%).

If we now compare performances on branching onsets to the internal coda, it appears that children with SLI scored significantly better on branching onsets than they did on internal codas (BiSLI: BO2/M2L z=2.75 p=.0058, BO3/M2L z=2.69 p=.007 ; MoSLI: BO2/M2L z=2.35 p=.018, BO3/M2L z=2.47 p=.013), as did the children in the BiTD group in disyllabic items (BO2/M2L z=2.71 p=.006, BO3/M2L z=1.045 p=.29). In monolingual TD children, no significant difference was found.

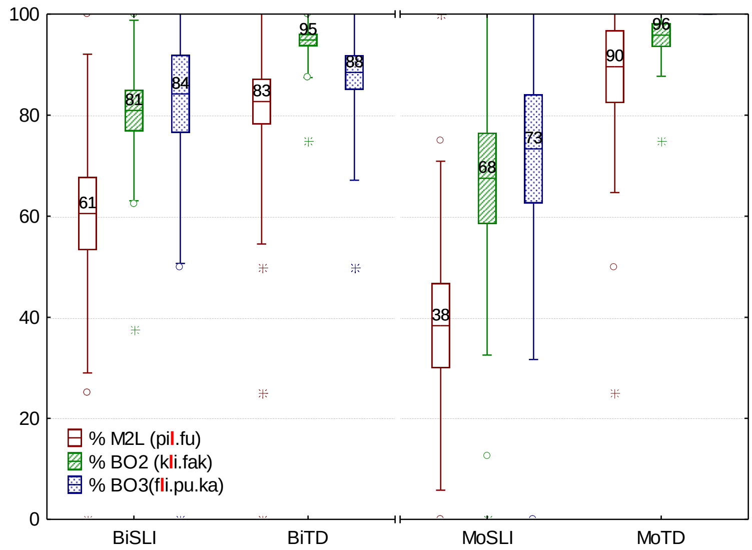


**Figure 4 Mean percentages of exact repetition on branching onsets (BO2 and BO3) and on internal coda (M2L) for each group of children**

It thus seems that branching onsets, even if they are sometimes problematic for children with SLI, are not reliable indicators of SLI in bilingual contexts.

### 4.5 Focus on complexity: final consonants

We will consider the final consonants which were the most subject to errors, i.e. the /s/ before a consonant in final position ‘FSC’ as in /pu**s**k/, and the final consonant alone ‘FC’ as in /ki**p**/. BiTD children performed as well as the MoTD children (FSC U=210 p=.48, FC U=225 p=.83). BiSLI children’s productions are not significantly different from those of BiTD children for ‘FSC’ structures (U=318 p=.12) but are significantly different for FC structures (U=235 p=.02). As for branching onsets, these two structures are above 85% of exact repetitions for BiSLI children.

Comparison between these final consonants and the internal coda consonants (Figure 5) shows that the internal coda always cause more errors than final consonants in children with SLI (BiSLI: FSC/M2L z=2.58 p=.0097, FC/M2L z=2.91 p=.0036 ; MoSLI: FSC/M2L z=1.64 p=.10, FC/M2L z=2.44 p=.014), but also in the BiTD group (FSC/M2L z=2.28 p=.017, FC/M2L z=2.21 p=.026).

As we saw for the branching onsets, final consonants appear to be less sensitive to discriminate SLI in bilingualism than the internal coda.

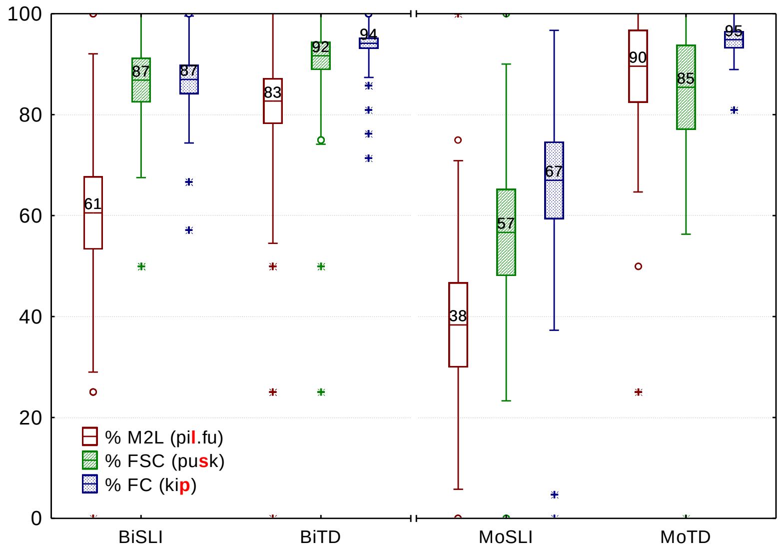


**Figure 5 Mean percentages of exact repetition on final consonants (FSC and FC) and on internal coda (M2L) for each group of children**

## 5 Discussion

We hypothesized that specific sensitivity to complexity in children with SLI would lead to a decrease of their performance when dealing with (complex) LD items. We supposed that these children's major difficulties are not linked to properties that need to be acquired in the L2, but rather to impairment. Our results show that performance on the LD part was worse only in monolingual children with SLI. Indeed, due to different places of recruitment (hospital versus SLT's offices), phonological impairment of the monolingual children with SLI is presumably more severe than the one of the BiSLI children (as more severed impaired children are more likely to be referred to diagnostic centers). If these children are more severely impaired, the lower level of complexity contained in the LI part could pose difficulties for them. This difference of severity could also be the explanation of all the observed differences between the monolingual and the bilingual children with SLI

The LD part was considered to be specific to French phonotactics. Thus, we assumed that this part could be more difficult for bilingual children that have to acquire these constraints. In fact, our results show that there is no difference between bilingual and monolingual children in their performances on the two parts of the test. An important point is that the first languages of those bilingual children (i.e. English, European Portuguese and Arabic) share with French most of the specific characteristics we added in LD items. The phonology of Turkish is more different from French for these properties. We are, however, unable to test this, since only one Turkish child has been tested so far. Although this result is not what was originally predicted, it means that the LI part is discriminant enough to assess SLI in children, which is important for bilingual children.

Our last hypothesis predicted that children with SLI would have difficulties dealing with consonants in complex syllable structures. Our results confirm this prediction: children with SLI have much more difficulty producing complex structures than simple structures. This result is similar to what has been found in the literature. However, we found that children do not process each complex structure equally. Indeed, it seems that for children with SLI some structures are more difficult than others. We saw that the internal coda is much more difficult than other complex structures such as branching onsets or final consonants. This leads us to think that the internal coda could be a reliable clinical marker for a phonological deficit, even in a bilingual context. This idea is supported by the fact that typically-developing bilingual children's performance on internal codas is equivalent to that of monolingual children. However, almost all the languages spoken by our participants (i.e. Arabic, English and European Portuguese) have an internal coda equivalent to the French one. Turkish is the only L1 language in our study that does not, but we so far have only one L1 Turkish child. Our data thus need to be completed with languages without codas in order to confirm the usefulness of this marker for SLI in bilingual contexts.

This study confirms that phonologically complex structures are valid indices for identifying SLI, even in bilingual contexts. Our results have singled out the internal coda as the best candidate to be a clinical marker of a phonological deficit.

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