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Language proficiency and study achievement of pupils with dyslexia enrolled in Content and Language Integrated Learning (CLIL)

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Abstract

To date, very little research has been conducted on the inclusiveness of CLIL for pupils with learning disorders. The current study investigated whether pupils with dyslexia may also benefit from a CLIL experience or whether reading disorders should rather be considered as a risk factor for attending CLIL. To address this question, 28 5th and 11th-grade pupils with diagnosed dyslexia and 112 matched controls were identified within a sample of over 800 participants recruited in French-speaking Belgium. A first analysis showed that CLIL pupils with dyslexia had similar participation rates as those schooled in traditional education. Secondly, our study provided no clear evidence for the intuition that dyslexia could have a more detrimental effect on French literacy in CLIL than in non-CLIL pupils. For the target language (i.e., Dutch or English), our findings were not entirely conclusive as to the linguistic advantage of CLIL pupils with dyslexia. Finally, the acquisition of academic content in a CLIL setting was comparable for both typically reading pupils and pupils with dyslexia. Overall, our findings suggest that there is no measurable disadvantage for pupils with dyslexia to attend CLIL, neither for language learning, nor for acquiring academic content.

Keywords : CLIL; dyslexia; foreign-language acquisition; bilingualism

Introduction

In a globalizing world, different approaches to promote bilingualism have emerged over the past few years. One of them is immersion education, an approach that aims to enhance second language proficiency by offering certain school subjects in a different language than the main school language. Immersion education has become a popular and widespread phenomenon in primary and secondary education worldwide. One particular variant of immersion education that has been implemented in Europe is known as Content and Language Integrated Learning (CLIL; European Commission / EACEA / Eurydice, 2023). In CLIL, the foreign language - i.e., the target language - is used as a medium for teaching non-linguistic content, such as history or mathematics. It is nowadays well-established that pupils enrolled in CLIL display higher foreign-language proficiency than pupils enrolled in traditional foreign-language instruction (Bulté et al., 2021; Hendrikx & Van Goethem, 2020; Van Mensel, Bulon, et al., 2020; for a meta-analysis, see Goris et al., 2019). Several studies also found that students enrolled in CLIL reported higher socio-affective states (e.g., De Smet et al., 2019) and have at least no lower academic outcomes or no poorer first language proficiency (e.g., Navarro-Pablo & López Gándara, 2020; Neveu et al., 2022; Pérez Cañado, 2018; San Isidro & Lasagabaster, 2019; for reviews, see e.g., Dalton-Puffer, 2011; Paradis et al., 2021). One timely and important question that has hardly been investigated is the extent to which CLIL programs offers an inclusive environment. In other words, is the CLIL approach also suitable and profitable for children and adolescents with learning disabilities, who constitute around 5-15 % of school-aged pupils (McDonough et al., 2017; Moll et al., 2014)? An increasing number of researchers, education professionals, and parents express some concern about the appropriateness of including children with learning disabilities in immersion programs (for a review, see Genesee, 2007). This caution may stem from the persistent myth that only academically gifted students can be taught in more than one language or that academic giftedness is rare in pupils with

learning problems (Genesee & Jared, 2008; Moes, 2018; Moret, 2011), which may keep children with learning disabilities from enjoying the benefits of immersion education or from receiving proper support. Therefore, it is about time to address this hardly documented issue, which currently leaves too much room for personal intuitions. In this study, we will focus on *language proficiency* and *study achievement* of children and adolescents with *developmental dyslexia* who are enrolled in CLIL. In what follows, we will first briefly define developmental dyslexia and then review the available evidence about foreign-language learning and immersion (including CLIL) in people with dyslexia.

Dyslexia is a neurodevelopmental disorder affecting around 7% of school-aged children worldwide (Yang et al., 2022). The disorder is characterized by persisting difficulties with reading (accuracy and/or fluency) and spelling, despite the absence of obvious factors explaining these difficulties (e.g., inadequate schooling or sensory impairments). Developmental dyslexia has a broader adverse effect on academic functioning, as also many non-linguistic tasks (e.g., problem solving) require literacy skills (Snowling et al., 2020). In terms of its etiology, most researchers agree that there is a central phonological deficit, meaning that individuals with dyslexia are less sensitive to the sound structure of language (for a recent study, see e.g., Snowling et al., 2019).

Recently, von Hagen and colleagues (2021) conducted a meta-analysis on the ability of children and adolescents with dyslexia to learn a foreign language. Their results revealed a lower level of foreign-language (English) proficiency in poor readers/spellers compared to their control peers. The latter conclusion was also supported in a recent literature review from Gasperini (2022), although he also highlighted the importance of considering inter-individual variability and potential influencing factors (e.g., verbal short-term memory abilities, linguistic similarities between the native and the foreign language). With respect to the context of

immersion, a very limited amount of research has been focusing on the appropriateness and effectiveness of immersion for children with so-called *special education needs (SEN)* (see Genesee & Lindholm-Leary, 2021; Paradis et al., 2021). This research showed that, in general, immersed children with SEN do not experience greater difficulties compared to their non-immersed peers, neither in their first language (English), nor in their academic outcomes. Moreover, they also attain higher levels of foreign-language (French) performance than their non-immersed peers with SEN (e.g., Kay-Raining Bird et al., 2021). Similar studies were undertaken on the "Two-Way Bilingual programs" in the U.S.A. (see e.g., Genesee & Lindholm-Leary, 2021; Paradis et al., 2021) and concluded that the participation in an immersion program does not compromise school achievement or proficiency in the majority language (English) of *struggling* or *at-risk* children. Despite these encouraging findings, an important limitation concerns the variety of difficulties grouped under the umbrella term of SEN, which makes it difficult to generalize these findings to well-defined disorders.

About a decade ago, Kruk and Reynolds (2012) conducted a longitudinal study in first to third graders involved in early French immersion or traditional English-only programs. The aim of their study was to investigate the influence of Canadian French immersion on English reading development in pupils who were considered "at-risk readers" by their teachers. To do this, proficiency in phonological awareness, decoding, and reading comprehension were compared between the "at-risk readers" and typically developing (TD) children. To reduce potential program-specific initial disparities, the immersed children were matched with non-immersed children in Grade 1 on IQ and reading-related abilities. After 2 years of immersion, they found that both immersed TD and immersed at-risk readers demonstrated better phonological awareness but also better decoding abilities compared to the non-immersed TD and at-risk readers, respectively. These observed benefits were of equal size for both at-risk and TD readers, leading to the conclusion that French immersion can positively impact reading

achievement, also in at-risk readers. The authors, however, admit that their inclusion criteria for the at-risk sample were rather "lenient", as they allowed the inclusion of pupils with moderate levels of reading difficulty. In the European context, a study was conducted by de Bree and Unsworth (2014) on students with and without dyslexia attending traditional and bilingual secondary education in the Netherlands. The study showed that students with dyslexia not only had the same reading skills in Dutch (the main language of instruction) as their non-immersed peers with dyslexia, but that they were also able to benefit from the immersion program in terms of spoken and written English (the target language) learning. However, these findings should also be interpreted with caution, given possible program-related (self-)selection biases (i.e., students enrolled in immersion may have higher initial language proficiency). Note also that the inclusion of participants with dyslexia occurred solely on the basis of intuitions from the school staff.

Altogether, previous studies seem to indicate that immersed children and adolescents with dyslexia may not be at greater risk of literacy problems and that they may even benefit from the linguistic advantages of immersion education, like their typically reading peers do. Nevertheless, the scarcity of evidence, in addition to the study limitations mentioned above, raises the question about the generalizability of these findings. The current study attempts to address a number of shortcomings of this earlier research.

First, to our knowledge, previous studies did not address the estimated prevalence of pupils with dyslexia in immersive school settings, which would provide valuable initial information about the natural access to these programs for children with dyslexia. The present study is part of a large-scale research project on immersive practices in French-speaking Belgium in which over 800 (Dutch or English) CLIL and non-CLIL learners were recruited (Hiligsmann et al., 2017). One major advantage of our approach is that we did not select participants for dyslexia, but we did recruit entire classes, without predefined exclusion criteria,

therefore ruling out any dyslexia-related sampling bias. Second, the 800+ participant sample allowed us to select a subsample of CLIL and non-CLIL control participants closely matched to the identified individuals with dyslexia, based on a range of potentially influencing background variables. Thirdly, we obtained data from two developmental stages, namely the end of primary school and the end of secondary school, offering an overview of the immersed profiles with dyslexia after an average of 6 years of CLIL, with a minimum of 3 years. Fourth, our study focuses on a population with a formal dyslexia diagnosis, which, unlike the majority of previous studies in children with SEN, will allow us to draw specific conclusions at the level of the individual disorder. Finally, whereas most studies restricted their evaluation to either measures of spoken language, literacy (in the main language of instruction or in the target language) or academic content acquisition, a major strength of this study is that we were able to examine all these linguistic and non-linguistic outcomes altogether. It is important to note that we used the results of the official Belgian (French-speaking) end-of-curriculum evaluation as a measure of school achievement. These external evaluations are mandatory for all pupils, whether enrolled in CLIL or not. These standardized measures allowed us to make a more objective comparison of learning outcomes between CLIL and non-CLIL children and adolescents, ruling out potential confounds due to evaluative differences between schools.

The first goal of the present study is to investigate whether and to what extent children and adolescents with dyslexia find their way to CLIL by comparing the prevalence rates of dyslexia among our samples of CLIL and non-CLIL pupils. Our second goal is to estimate whether dyslexia may put pupils more at risk in CLIL programs and if not, whether pupils with dyslexia can also take advantage of the CLIL approach, just like their typically reading peers do. To this end, we compared CLIL and non-CLIL pupils with or without dyslexia in terms of linguistic abilities in both the main school language and the (target) foreign language, as well as in terms of acquired academic content.

Method

Participants

First of all, it should be noted that there is no selection procedure in Belgium to enter CLIL education; it is accessible to all students (Van Mensel, Hiligsmann, et al., 2020). The pupils with dyslexia and the matched control participants were identified within a sample of over 800 participants involved in a large-scale study comparing CLIL with non-CLIL education in French-speaking Belgium (Hiligsmann et al., 2017). The participating children and their parents completed a sociolinguistic and anamnestic questionnaire. Participants with dyslexia were identified through the question: *Has your child been diagnosed with dyslexia?* In the entire sample, we identified 36 parent-reported individuals with diagnosed dyslexia. However, 6 participants with dyslexia were excluded due to the comorbid presence of a developmental language disorder, a hearing impairment, a "mixed" educational track (i.e., CLIL primary schooling and non-CLIL secondary schooling) or because of missing data. As a result, the sample for the current study amounted to 140 participants: 28 pupils with dyslexia and 112 matched controls. Regarding the pupils with dyslexia, 17 were enrolled in CLIL whereas 11 were enrolled in non-CLIL education. 18 children were in fifth grade of primary education (M_{age} = 10.5 years) and 10 adolescents were in eleventh grade (equivalent to the fifth grade of secondary education) (M_{age} = 16.5 years) at the start of the project. The target language was either English or Dutch. The primary CLIL pupils had already completed between 3 and 6 school years in CLIL classes, while secondary CLIL adolescents have been enrolled in this program for minimum 3 up to 12 school years. Some pupils had already started as early as legally possible in French-speaking Belgium, which is in 3rd kindergarten (i.e., preceding Grade 1, corresponding to ages 5-6).

In non-CLIL education, foreign-language courses were introduced in the fifth grade for one hour per week in primary education, while adolescents received four hours per week of

foreign-language instruction in secondary education. In the current study, the average proportion of the subjects taught in the target language ranged from 47 to 60% over the first 5 years of primary school for the youngest CLIL participants. This number varied between 19 and 32% over the first 5 years of secondary school for the oldest CLIL participants (see Hambye, 2009; Mettewie & Mensel, 2020 for a historical and current state overview about CLIL in Belgium). The other subjects are taught in the main school language, i.e. French. Note that according to Belgian legislation, school authorities enjoy significant autonomy in the practical implementation of CLIL, with a few formal requirements regarding the TL, the age of onset and the proportion of weekly hours provided in the TL (within a specified range) (Hiligsmann et al., 2017).

112 individuals were matched with the dyslexic group at a 4:1 ratio on School Level (primary or secondary), Target Language (English or Dutch), Instruction Method (CLIL or non CLIL), Socio-Economic Status (SES), Bilingualism[1], Number of Years in CLIL (for CLIL participants only), Non-Verbal Intelligence, and Receptive Vocabulary in French (see Materials and Procedure). The matching was carried out by means of the propensity score matching method (Rosenbaum & Rubin, 1983) in IBM SPSS Statistics (Version 27). A four-to-one matching ratio is known to offer a good bias-variance trade-off (Austin, 2011; Linden & Samuels, 2013).

Although recruitment occurred at the level of full school classes, each child agreed to participate on a voluntary basis. Parental consent was obtained for each participating child. The procedure was approved by the Ethics Committee of the Psychological Sciences Research Institute at the Université catholique de Louvain (UCLouvain, Belgium).

[1] Bilingualism refers to the proficiency and frequency of use of languages other than French outside the school context.

Materials and Procedure

The data collection took place mainly during the first quarter of the 2015-2016 school year. Participants were assessed within their school as well as in the computer rooms of the UCLouvain.

Background measures

Measures of non-verbal intelligence and French receptive vocabulary were used as background measures. Non-verbal intelligence was measured using Raven's Standard Progressive Matrices (Raven et al., 1998). French receptive vocabulary knowledge was assessed with the Échelle de Vocabulaire en Images Peabody (EVIP; Dunn et al., 1993). Descriptive statistics for the different characteristics and background variables of our participants, by Dyslexia (dyslexia vs. control) and Instruction Method (non CLIL vs. CLIL), for the two School levels (primary and secondary), are given in Table 1.

French literacy

French reading skills were assessed individually using the Alouette-R (Lefavrais, 2005). Participants are asked to read aloud a meaningless 265-words text, which however consists of typical French linguistic structures. This task allows us to obtain a reading accuracy index and a reading speed index. For both indexes, the higher the score, the better the performance.

For the pupils in the 5th year of primary education, spelling skills were assessed in groups, using the 'Chronosdictées' (Baneath et al., 2006), a sentence dictation test. For 11th-grade students, a text dictation of 213 words taken from the EVALAD battery (Pech-Georgel & George, 2011) was administered in groups.

Table 1

Descriptive statistics for background information for participants with Dyslexia or without (Control) in the CLIL and non-CLIL groups as a function of School Level.

	Dyslexia		Control	
Primary	CLIL	non CLIL	CLIL	non CLIL
N	12	6	43	29
Age in years	10.62(0.52)	10.38(0.70)	10.30(0.29)	10.59(0.55)
Years in CLIL	4.83(0.83)	/	4.91(1.09)	/
Dutch/English	8/4	3/3	33/10	18/11
Gender F/M	9/3	3/3	25/17	15/14
Bilingualism 1/2	9/3	6/0	29/14	15/14
SES 1/2/3	2/7/3	3/3/0	9/14/20	13/11/5
N-v. intelligence	29.58(6.69)	27.33(9.16)	28.19(6.79)	26.61(7.00)
French rec. voc.	105.08(13.02)	103.17(28.28)	102.49(18.85)	104.72(17.81)
Secondary				
N	5	5	22	18
Age in years	16.60(0.28)	16.39(0.39)	16.22(0.46)	16.89(0.78)
Years in CLIL	8.20(3.83)	/	6.05(3.36)	/
Dutch/English	3/2	4/1	15/7	13/5
Gender F/M	5/0	3/2	11/11	11/7
Bilingualism 1/2	4/1	4/1	19/3	15/3
SES 1/2/3	0/2/3	1/2/2	3/10/9	4/10/4
N-v. intelligence	49.20(5.40)	41.20(1.48)	46.36(7.57)	41.39(9.94)
French rec. voc.	146.00 (4.69)	141.00(3.81)	143.68(6.41)	139.94(9.28)

Note. Bilingualism (1=no other language known/used/ 2= one or more languages known/used outside school in addition to French); SES, estimated using the mother's highest degree of education (1=primary or secondary education/ 2=higher education /3=university degree); N-v. intelligence=Non-verbal intelligence; French rec. voc.=French receptive vocabulary.

Foreign-language receptive vocabulary

Foreign-language receptive vocabulary was measured using an untimed picture designation task: the PPVT-III-NL (Dunn & Dunn, 2005) and the PPVT-IV (Dunn & Dunn, 2007) for Dutch and English, respectively.

School achievement

Finally, at the end of the next school year 2016-2017, 16 schools out of the 21 agreed to share the official external end-of-curriculum evaluations of participating pupils. These evaluations allow all pupils in French-speaking Belgium to be assessed on the same basis and to certify that they attained the learning outcomes of the assessed subjects at the end of their curriculum. Regardless of the instruction method (CLIL or non CLIL), these official end-of-curriculum tests are always assessed in French. Passing these tests, in addition to the traditional internal examinations organized by each school, gives access to the *Certificat d'Études de Base* (CEB ; certificate of basic education) or the *Certificat d'Enseignement Secondaire Supérieur* (CESS ; certificate of upper secondary education), respectively. The CEB external certification test evaluates French, mathematics, sciences, and history/geography, while the CESS external certification test evaluates French and history.

Data analysis

We first verified that the skewness and kurtosis values were acceptable (Kim, 2013) to determine whether the assumption of normality of data distribution was met. In order to answer our research questions, we ran linear mixed models (LMMs) (see e.g., Baayen et al., 2008; Barr et al., 2013 for detailed descriptions of the strengths of these models). LMMs were conducted for each dependent variable. Dyslexia and Instruction Method were systematically entered as fixed factors. We also included interactions between Dyslexia and Instruction Method. A random intercept was added for Clusters of participants (one cluster included one participant with dyslexia and its four matched controls). To maximize statistical power, analyses were conducted jointly for both school levels (primary and secondary) except for Spelling because a different test was used for each school level. School level was therefore included as control variable, except for the LLMs for Spelling and Foreign-language proficiency (as z-scores were

calculated separately for each school level, see the dedicated section below). The sample size (N) is indicated for each model. Finally, SES, non-verbal intelligence, and vocabulary knowledge were included as covariates when possible. Indeed, these factors are known to influence, to some extent, literacy skills (Duff et al., 2015; Hemmerechts et al., 2017; Peng et al., 2019), foreign/second-language receptive vocabulary (Martínez-Agudo, 2019; Senar et al., 2023; Woumans et al., 2019) and school achievement (Giofrè et al., 2017; Wang & Wu, 2023; Wang et al., 2023) to some extent. This also allowed us to take into account possible disparities between CLIL and non-CLIL populations in relation to these factors (Caira et al., 2023; Van Mensel, Hiligsmann, et al., 2020). We were not able to systematically control for non-verbal intelligence or French receptive vocabulary because of the collinearity between these two variables ($r = .730$, $p < .001$), causing problems with the convergence of the LMMs. In cases of significance, we further explored the Dyslexia x Instruction Method interaction with contrast analyses. A Bonferroni correction was applied to the *p*-values. In terms of effect sizes, we calculated Nagelkerke's R-squared from the LLMs for significant main effects and interactions. We additionally reported Cohen's *d* in the case of pairwise contrasts.

Results

Analyses were conducted using IBM SPSS Statistics (IBM Corporation, 2021) predictive statistics software, except for the calculation of effect sizes, which was carried out using RStudio (Rstudio Team, 2023). The significance level (α) was fixed at .05 for all the analyses.

Prevalence of dyslexia in CLIL

In the entire project sample of 831 participants, the children and adolescents with dyslexia accounted for 3.46% of pupils enrolled in CLIL education (4.8% in primary and 2.56% in secondary school) and for 3.72% of pupils enrolled in non-CLIL education (5.3% in primary

and 2.33% in secondary school). Chi-square tests showed that the proportions of pupils with dyslexia in CLIL and in non-CLIL education did not differ significantly ($\chi^2(1) = .040$, $p = .842$), neither in primary ($\chi^2(1) = .046$, $p = .830$), nor in secondary schools ($\chi^2(1) = .027$, $p = .870$).

French literacy

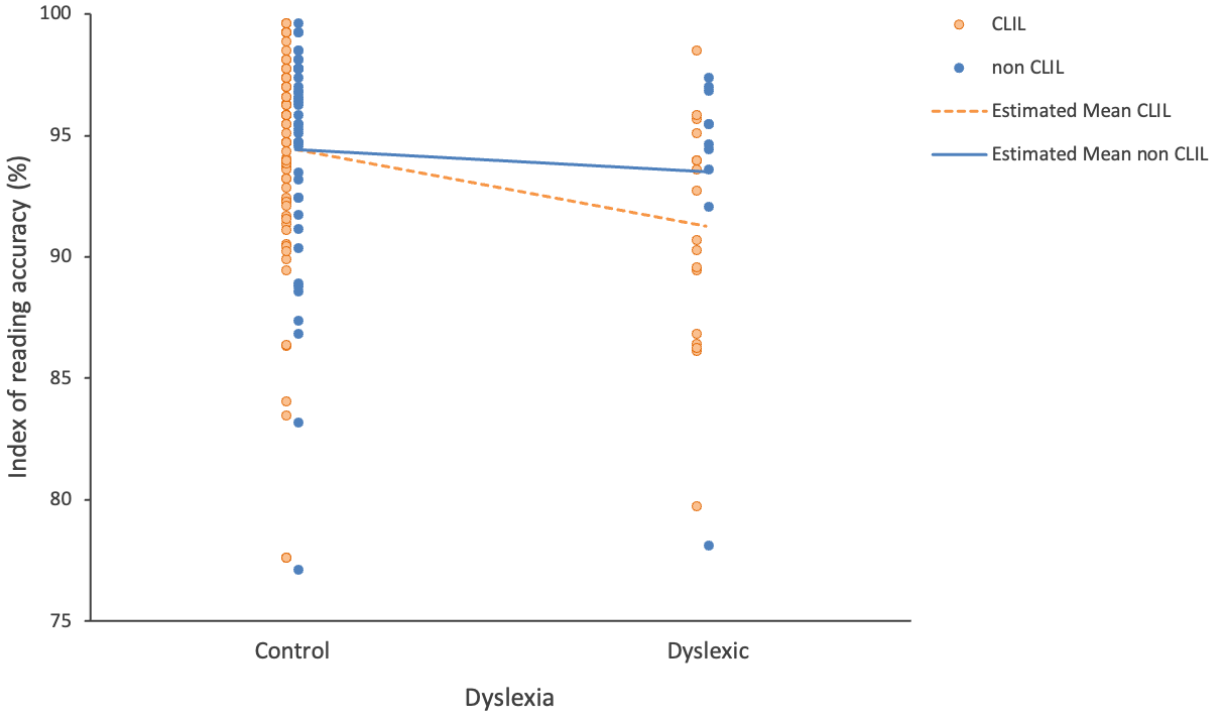
Reading

The Alouette-R reading accuracy index represents the percentage of words read correctly. As the data were not normally distributed, we applied a transformation to this variable (ln (- y + 100)) allowing us to reach acceptable values of skewness and kurtosis. The transformed variable was therefore the dependent variable in the following analysis. We carried out a LLM with Dyslexia and Instruction Method as fixed factors, with Clusters of participants as a random factor (intercept) and with School level, SES and Non-verbal intelligence as control variables ($N = 135$). The Dyslexia x Instruction Method interaction was also entered in the model. A significant effect of Dyslexia was observed ($F(1,127) = 11.610$, $p < .001$, $R^2 = .062$) but no significant main effect of Instruction Method. The Dyslexia x Instruction Method interaction was not significant. Figure 1 illustrates these results.

Next, the Alouette-R reading speed index was used as dependent variable. This index is calculated by multiplying by 180 (the maximum reading time in seconds) the number of words read correctly and subsequently dividing that value by the actual reading time. The higher the index, the better the reading speed performance. The LLM included Dyslexia and Instruction Method as fixed factors (in addition to their interaction), Clusters of participants as a random factor (intercept), and School level, SES, French receptive vocabulary, and Non-verbal intelligence as covariates ($N = 135$). The results revealed a significant main effect of Dyslexia ($F(1,126) = 7.095$, $p < .01$, $R^2 = .021$) but no significant main effect of Instruction

Figure 1

Reading accuracy index as a function of Dyslexia and Instruction Method When School level, SES and Non-verbal intelligence are controlled for



Note. The figure shows the untransformed data.
[a] In order to improve the visibility of the data distribution, the score of one non-CLIL control participant (65.35) is not visible here.

Figure Alt Text: Scatter plot showing individuals and estimated means (EM) by group. The EM for the CLIL dyslexic group appears slightly lower than for the other 3 groups.

Method. The Dyslexia x Instruction Method interaction was significant ($F(1,126) = 9.407$, $p = .05$, $R^2 = .018$) indicating a larger effect of dyslexia in the CLIL than in the non-CLIL group. A subsequent contrast analysis revealed significantly poorer reading speed performance for pupils with dyslexia compared to control pupils in CLIL ($t(126) = 4.288$, $p < .001$, $d = 1.196$). In non CLIL, the difference between pupils with dyslexia and control pupils did not reach significance. Figure 2 illustrates these results.

Spelling

Figure 2

Reading speed index as a function of Dyslexia and Instruction Method when School level, SES, French receptive vocabulary and Non-verbal intelligence are controlled for

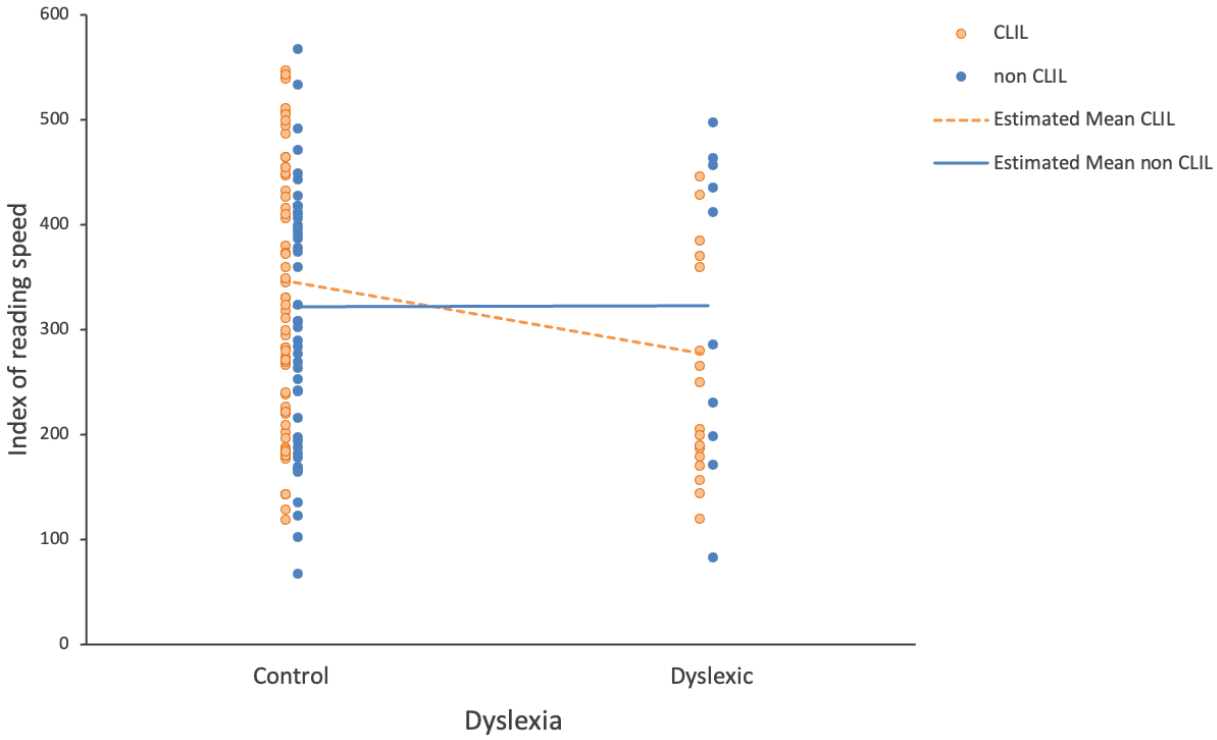


Figure Alt Text: Scatter plot showing individuals and estimated means (EM) by group. The EM for the CLIL dyslexic group appears slightly lower than for the other 3 groups.

For the primary school level, the LLM included Dyslexia and Instruction Method as fixed factors (and their interaction), Clusters of participants as a random factor (intercept), and SES, French receptive vocabulary and Non-verbal intelligence as control variables (N = 84). The results showed a significant effect of Dyslexia ($F(1,76) = 5.012$, $p < .05$, $R^2 = .071$) but no significant effect of Instruction Method. The Dyslexia x Instruction Method interaction was not significant either. Figure 3 illustrates these results.

For the secondary school level, we carried out a LLM with Dyslexia and Instruction Method as fixed factors (and their interaction), with Clusters of participants as a random factor (intercept) and with SES and French receptive vocabulary as control variables (N = 50). We

Figure 3

Number of spelling errors as a function of Dyslexia and Instruction Method in primary education when SES, French receptive vocabulary and Non-verbal intelligence are controlled for

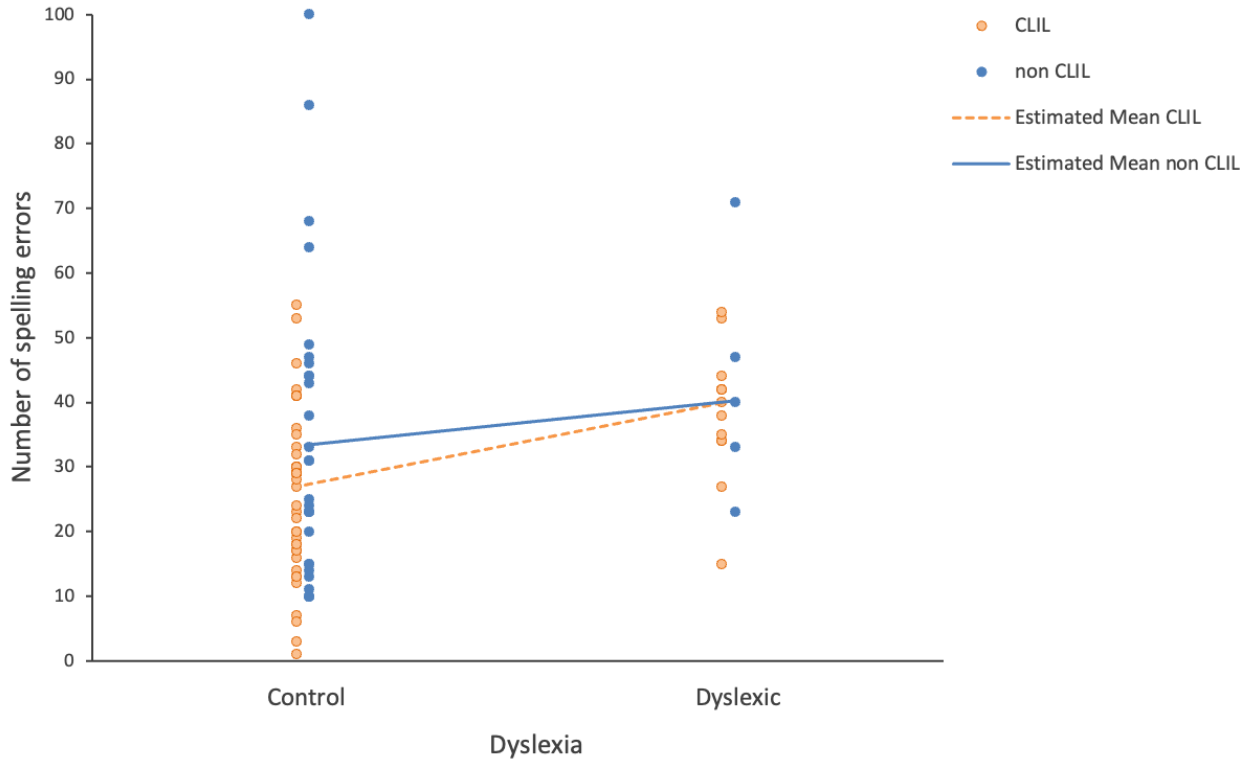


Figure Alt Text: Scatter plot showing individuals and estimated means (EM) by group. The EMs for pupils with dyslexia are significantly higher than for control pupils. The EM for CLIL control pupils appears slightly lower than for non-CLIL control pupils.

only found a significant effect of Dyslexia ($F(1,43) = 5.348$, $p < .05$, $R^2 = .096$). Figure 4 illustrates these results.

Foreign-language receptive vocabulary

As a dependent variable, we used z-scores derived from the PPVT-NL-III (Dutch) and the PPVTV-IV (English) raw scores, given that both tests use different scales. We calculated the z-derived scores on the basis of the score distributions of the sample of over 800 participants, separately for each school level and excluding the participants with dyslexia. The LLM included Dyslexia and Instruction Method as fixed factors, Clusters of participants as a random

Figure 4

Number of spelling errors as a function of Dyslexia and Instruction Method in secondary education when SES and French receptive vocabulary are controlled for

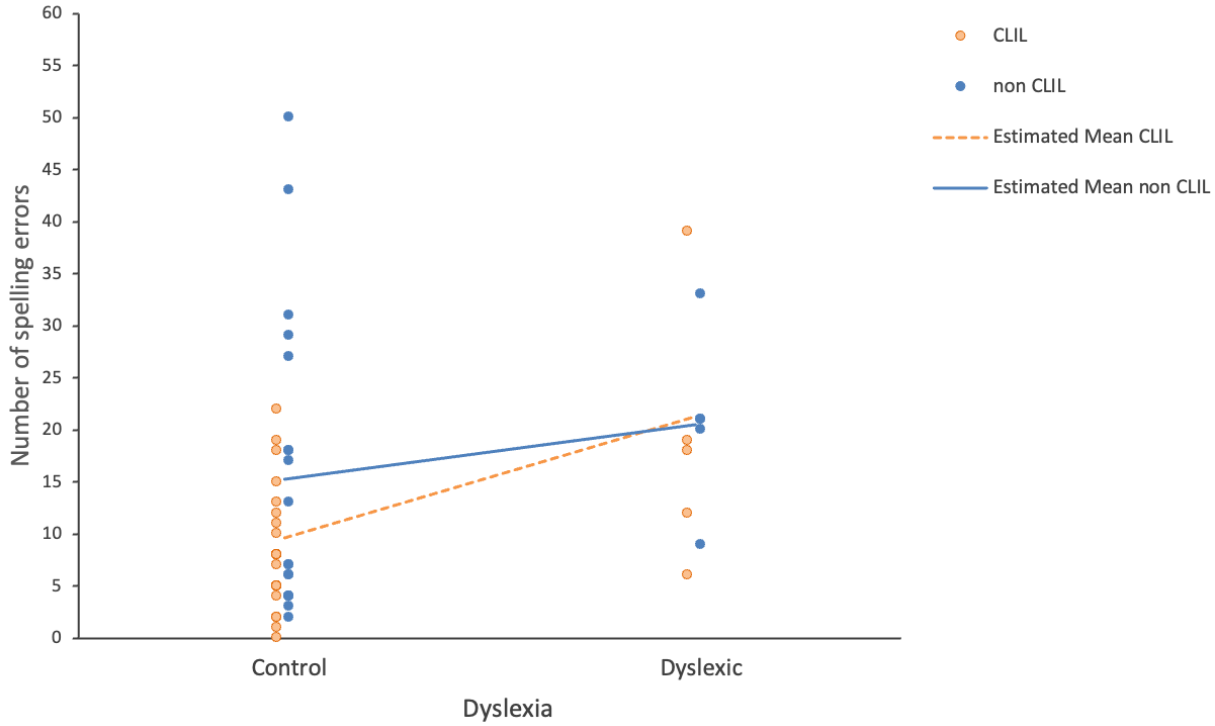


Figure Alt Text: Scatter plot showing individuals and estimated means (EM) by group. The EMs for pupils with dyslexia are significantly higher than for control pupils. The EM for CLIL control pupils is lower than for non-CLIL control pupils.

factor (intercept), and School level, SES, French receptive vocabulary, and Non-verbal intelligence as covariates (N = 139). The Dyslexia x Instruction Method interaction was also entered in the model. The results showed a significant main effect of Instruction Method ($F(1,131) = 9.645$, $p < .01$, $R^2 = .198$) indicating better foreign-language receptive vocabulary in the CLIL group. The main effect of Dyslexia was not significant. The Dyslexia x Instruction Method interaction was however significant ($F(1,131) = 7.276$, $p < .01$, $R^2 = .017$), suggesting higher foreign-language receptive vocabulary in CLIL among control pupils but not among pupils with dyslexia.

Pairwise contrasts revealed that CLIL control pupils showed greater foreign-language receptive

Figure 5

Foreign-language receptive vocabulary as a function of Dyslexia and Instruction Method when SES, Non-verbal intelligence and French receptive vocabulary are controlled for

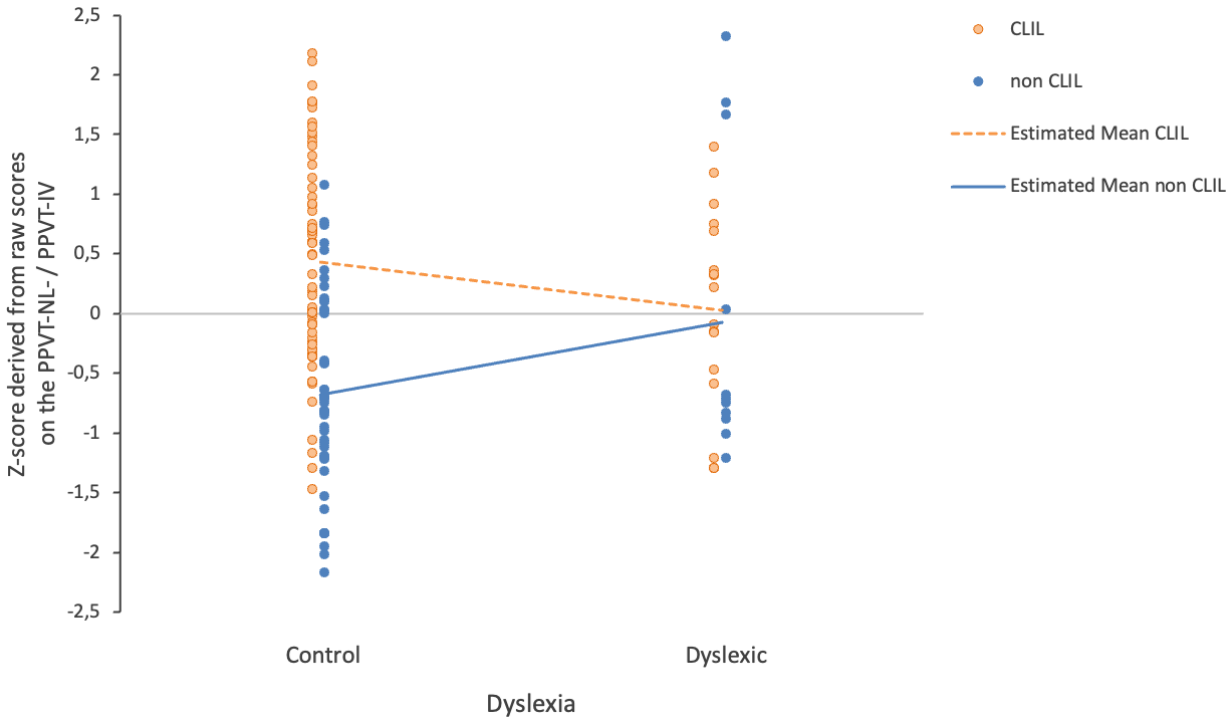


Figure Alt Text: Scatter plot showing individuals and estimated means (EM) by group. The EM for CLIL control pupils is significantly higher than for non-CLIL control pupils. The EM for non-CLIL control pupils appears lower than for non-CLIL pupils with dyslexia. The EM for CLIL control pupils appears slightly higher than for CLIL pupils with dyslexia. A cluster of 3 non-CLIL pupils with dyslexia exhibit higher scores.

vocabulary than non-CLIL control pupils ($t(131) = 6.336$, $p < .001$, $d = 1.305$) while no significant difference was observed between CLIL and non-CLIL pupils with dyslexia. Figure 5 illustrates these results. Furthermore, we found no significant difference in foreign-language vocabulary levels between control pupils and pupils with dyslexia enrolled in CLIL.

School achievement

We used the average CEB/CESS evaluation scores (percentages) as a measure of school achievement. We carried out a LLM with Dyslexia and Instruction Method as fixed factors

Figure 6

Global school results on the CEB/CESS as a function of Dyslexia and Instruction Method when School level, SES and Non-verbal intelligence are controlled for

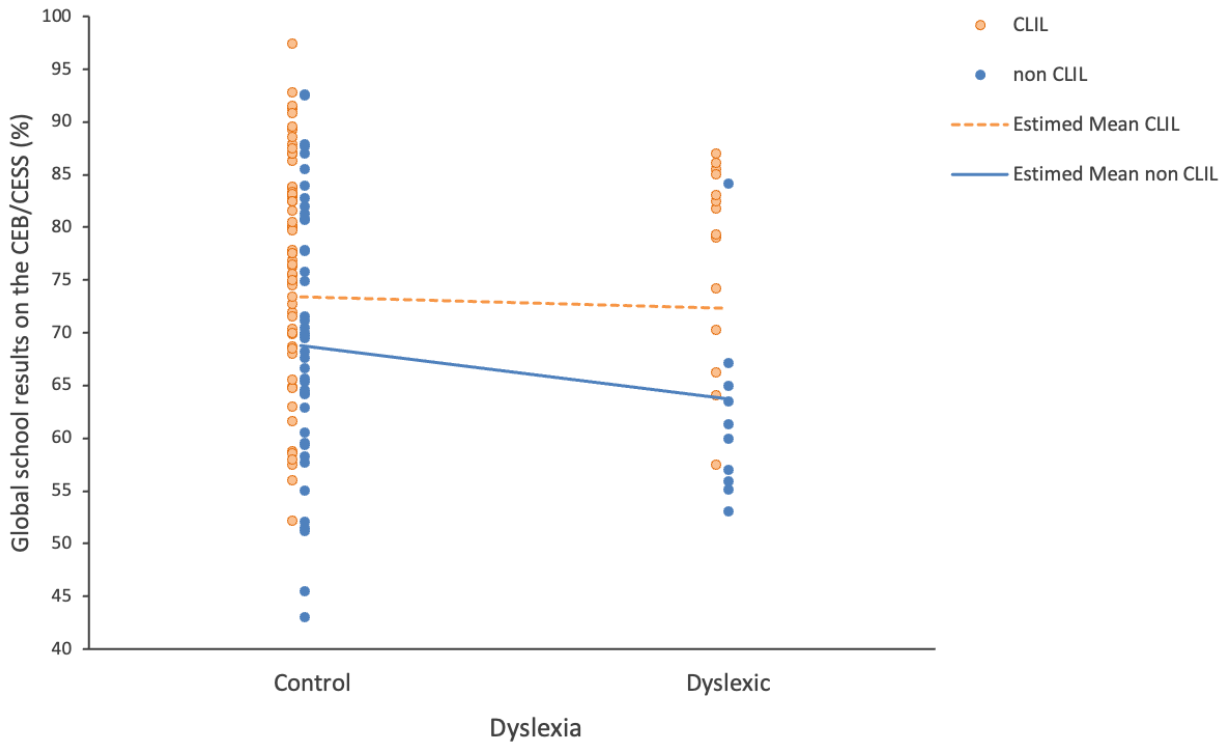


Figure Alt Text: Scatter plot showing individuals and estimated means (EM) by group. The EMs for CLIL pupils are significantly higher than for non-CLIL pupils, both for control pupils as for pupils with dyslexia. Also, the EM for non-CLIL pupils with dyslexia is slightly lower than for non-CLIL control pupils.

(with their interaction), with Clusters of participants as a random factor (intercept) and with School level, SES and Non-verbal intelligence as control variables (N = 123). The results revealed a main effect of Instruction Method ($F(1,115) = 7.412$, $p < .01$, $R^2 = .095$) in favor of the pupils in CLIL. But neither the main effect of Dyslexia, nor the Dyslexia x Instruction Method interaction were significant. Figure 6 illustrates these results.

Discussion

Although immersion education approaches, such as CLIL, have gained much popularity worldwide, very little is known about its accessibility and feasibility for children and

adolescents with learning disorders. As such, the first goal of our study was to obtain an estimate of the prevalence of dyslexia in CLIL education and to examine whether it is comparable to its prevalence in traditional non-CLIL education. Our second goal was to provide an elaborate analysis of the linguistic and academic profile of (CLIL) children and adolescents with dyslexia, in order to investigate the extent to which (1) the reading disorder can be considered a risk factor for entering CLIL education, and (2) pupils with dyslexia can benefit (or not) from the advantages promoted through this particular bilingual education method. One major advantage of our study is that the pupils with dyslexia were identified post hoc within a large sample of participants, which minimizes the variety of risks related to selection biases in learning disorder research.

Regarding the participation of pupils with dyslexia in CLIL, our results showed a similar dyslexia prevalence of around 3.5% in CLIL education and in non-CLIL education (3.46% and 3.72%, respectively). These findings suggest that children and adolescents with dyslexia find their way to immersion education like their typically reading peers do, at least in French-speaking Belgium. However, one might suspect that CLIL pupils with dyslexia may present milder profiles of disability compared to non-CLIL pupils with dyslexia. A priori, the overall literacy performance observed in the present study does not seem to point in that direction (see next section). However, to rule out the possibility that there were initial disparities that faded over time - meaning that CLIL pupils with dyslexia could perhaps make less progress than their non-CLIL peers -, it would be necessary to set up a longitudinal follow-up from the start of the CLIL program. At this stage, it can also not be excluded that the number of undiagnosed problematic readers is higher in traditional education due to the relatively lower socio-economic and cultural capital of families in this track (for French-speaking Belgium, see Van Mensel, Hiligsmann et al., 2020). This could also explain why the prevalence rate obtained in

the present study is somehow lower than what would be expected based on the average dyslexia prevalence rate in French-speaking Belgium (which is around 7%).

Next, we discuss the observed literacy skills in French, our participants' main language of instruction. First, we observed that pupils with dyslexia scored lower on all the literacy measures compared to the control pupils, as can be expected following a formal diagnosis of dyslexia. Descriptive statistics further suggest that the gap between control pupils and pupils with dyslexia is bigger in CLIL than in non CLIL for both reading accuracy and speed, but this difference was only significant for reading speed. For spelling (in both primary and secondary education), pupils with dyslexia made a similar number of errors in CLIL and non CLIL, while control pupils made less errors in CLIL than in non CLIL. However, the interaction between Dyslexia and Instruction Method was not significant. Globally, these findings are in agreement with the few similar studies reporting that being enrolled in immersion does not make pupils with dyslexia more prone to struggle with literacy problems (de Bree & Unsworth, 2014; Kruk & Reynolds, 2012). As such, our findings also suggest that immersed children with dyslexia can acquire literacy skills through the daily use of multiple languages, which is in line with the Linguistic Interdependence Hypothesis (Cummins, 1991). In this regard, our study aligns with earlier research about bilingual language development in children and adults with dyslexia (see Lallier & Carreiras, 2018).

We now focus on foreign-language proficiency, i.e. our participants' skills in the target language of CLIL, i.e. Dutch or English. First, our results in the control participants show that CLIL pupils performed largely better on the target language than non-CLIL pupils (d = 1.305). These results are in line with several other studies that have found higher target language proficiency among immersed pupils (for a meta-analysis, see Goris et al., 2019; for a recent study on vocabulary acquisition, see e.g., Jafarigohar et al., 2022). As far as our pupils with dyslexia are concerned, we found no measurable linguistic superiority for the CLIL learners.

Nevertheless, our results also indicate that CLIL pupils with dyslexia showed comparable target language skills as their typically reading CLIL peers. In this sense, our data remain unconclusive about whether the foreign language benefits of CLIL differ between pupils with dyslexia and typically reading pupils. Differences in the size of the benefit could perhaps be expected by the impaired phonological processing abilities, which are a hallmark of dyslexia (e.g., Peng et al., 2022). Indeed, a set of previous studies (e.g., Fazio et al., 2021; Palladino & Ferrari, 2008; Swanson et al., 2004) concluded that deficient phonological processing abilities may be a risk factor in learning a foreign language. The reason is that phonological subsystems such as verbal short-term and working memory (phonological loop) underlie the establishment of adequate phonological representations, allowing for long-term retention of new word sound structures. We therefore tentatively conclude that foreign language skills appear to be comparable for typical readers and pupils with dyslexia in CLIL, but the extent to which this reflects a gain relative to traditional education is a question that merits to be further investigated, particularly in CLIL pupils with dyslexia.

Regarding school achievement, our results indicate that CLIL pupils perform slightly better than their non-CLIL peers on the end-of-curriculum school exams (CEB/CESS), which aligns with previous findings (e.g., García-Centeno et al., 2020). Most importantly, our findings suggest that this CLIL advantage in academic content also emerges in pupils with dyslexia. This advantage cannot be confounded with the frequently highlighted higher socioeconomic status and/or intelligence profile of children enrolled in CLIL (e.g., Van Mensel, Hiligsmann, et al., 2020) because we controlled for these factors. These findings fit well with previous studies showing a higher percentage of academic achievement (Kay-Raining Bird et al., 2021) or better academic skills (Myers, 2009) in children identified as having SEN and enrolled in North American immersion compared to their peers in traditional education. More particularly, our study provides the first evidence for the ability of pupils with dyslexia to consolidate

academic knowledge in a target language and then to reproduce it in French during school assessments.

As a general limitation of our study, it must be kept in mind that the current study design does not allow us to make a clear-cut distinction between potentially added difficulties or benefits related to CLIL, difficulties related to dyslexia, and differences that reflect initial disparities between groups. As well, it seems reasonable to assume that, given the heterogeneity of dyslexia, not all children and adolescents will experience the same effects of CLIL. Indeed, it cannot be ruled out that the CLIL participants with dyslexia have cognitive abilities that are more favorable and better suited to the CLIL setting in terms of severity, cognitive mechanisms underlying reading, comorbidities, favorable attitude towards foreign languages, etc. compared to non-CLIL peers with dyslexia. Our data do, however, give us an overview of the profiles of long-term immersed pupils with diagnosed dyslexia in terms of linguistic, literacy and academic abilities in comparison to their non-immersed peers and to typically developing readers.

Future steps can involve a targeted (but hence more biased) recruitment of a larger sample of pupils with dyslexia participating in CLIL programs and a more comprehensive set of measures to better profile them. Furthermore, it would be interesting to compare the profiles of pupils with dyslexia immersed in different target languages, especially when the target languages differ in terms of orthographic depth. Regarding the study design, a longitudinal follow-up study with initial, baseline measurements taken before entering CLIL programs would enable us to control the initial (in)equivalence between CLIL and non-CLIL learners with dyslexia (on a set of relevant characteristics). This would thus allow us to estimate with more precision how much of the variability in the long-term results can be explained by CLIL. Finally, after demonstrating through this study that pupils with dyslexia do find their way to CLIL programs, an imperative next step will be to investigate how these programs provide

academic support for pupils with learning disabilities, to promote and improve the inclusiveness of immersion education.

Conclusion

The current study first showed that, as far as French-speaking Belgium is concerned, the participation rates of children and adolescents with dyslexia are similar in CLIL education as in CLIL education. Secondly and most importantly, our findings suggest that participating in immersion education does not seem to markedly compromise the literacy development in the main language of instruction or the school achievement of children and adolescents diagnosed with dyslexia. Furthermore, our study suggests that CLIL pupils with dyslexia can benefit from learning content in a foreign language in the sense that they yield better school outcomes compared to their non-CLIL peers with dyslexia. CLIL students with dyslexia also attain foreign language skills that are close to those of their typically reading CLIL peers, although we reserve a certain degree of uncertainty about whether this reflects comparable gains relative to traditional education for both groups. We conclude that dyslexia does not appear to be a risk factor for the outcomes of CLIL, at least not to a measurable extent, within the limits of our sample. These findings yield particularly valuable answers for all stakeholders involved in the accessibility of immersion education (beyond just CLIL) for atypically developing children and adolescents.

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Declaration of interest statement

The authors report no conflict of interest.

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