

# Age of onset effects on second language reading accuracy. Evidence from Czech children reading in English.

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**Abstract.** This study investigates the role of L2 age of onset on reading accuracy in a sample of Czech children learning English. The study was performed on two groups of children: a group who had been exposed to English since kindergarten and a group who had been exposed to English since primary school. Forty participants (20 in each group) aged between 8 and 12 years were tested using a standardized reading task. Reading accuracy was calculated with measures of substitutions, mispronunciations, refusals, additions and omissions. The results show that mispronunciations were the most common type of mistake among these children, followed by substitutions, and there was no significant difference between early and late-onset children in overall number of mistakes. However, when considering the subset of substitution errors, early onset children did outperform late onset children. These findings are discussed in relation to previous literature on age of onset effects and reading.

**Keywords:** Second language, age of onset, Czech, English, reading, pronunciation, phonology

## 1 Introduction

It is common in today's European society for children to start learning English as a second language at a relatively young age. In the Czech educational system, the first exposure to English takes place within the first 8 years of schooling, even if the exact starting date for English classes is not unified. Some children start to learn English in kindergarten, some begin in the first year of primary school, some begin in the third year of primary school. In recent years, early exposure schools (bilingual nurseries) have become more common, so some children begin to learn English as a second language as early as 1 year of age.

This article deals with the effects of age of onset on second language learning, and, more particularly, on reading accuracy. Considering the fact that the age of onset is not uniform in the Czech educational system, the purpose of this study is to examine whether age of onset has a role in learning and, as a consequence, the study also aims at giving an indication as to whether the age at which children first begin to learn English in Czech schools shall be unified or not. Effects of age of onset have gained considerable interest in bilingualism research in the last twenty years. The general notion that arises from this research body is that it is easier for learners with an early age of onset to develop native-like skills than it is for all of the other groups (Kovelman, Baker & Petitto 2008, Meisel 2010), even though age of onset effects can be mitigated when a later age of onset is accompanied by extensive exposure (Birdsong 2018, Pfenninger & Singleton 2019).

One important terminological distinction shall be made, since it can help to discuss these phenomena: The distinction between simultaneous and sequential bilingualism. Simultaneous bilingualism happens when a child is being exposed to all of their languages from birth. Sequential bilingualism, on the other hand, happens when a child begins acquiring other languages after mastering the initial stages of their mother tongue (Schmid 2010, Amengual 2019). Learning a foreign or second language may be a more or less unconscious and automatic activity depending on the age at which it begins: When it comes to learners with a very early age of onset, such as simultaneous bilinguals, their potential proficiency may be native-like, and their learning may be totally unconscious and automatic (Davison 2009). More variation is instead observed in sequential bilinguals (Kohnert 2008). Different kinds of sequential bilingualism are discussed for the purposes of this study. As previously mentioned, a simultaneous bilingual is someone who begins learning all of their lan-

languages right after birth. A sequential bilingual is instead someone who is exposed to the second language sometime after birth, during childhood, even though this definition encompasses a large group of children with very different profiles. A further subdivision is suggested by some researchers: An early sequential bilingual may be described as a child who began learning a second language in kindergarten, while a late sequential bilingual may be described as a child who began being exposed to English in the first or third grade of primary school (Babatsouli & Ball 2020). While the participants of this study are not bilinguals in a narrow sense, since they have a clear dominance in Czech and are only exposed to English through schooling, we will retain these time thresholds of exposure as references for the groupings of our samples (nursery vs. primary school).

The age at which a learner first comes into contact with their second language is known with the term “age of onset”. Several studies have centered on the native-likeness of second-language knowledge, and some have suggested that with adequate exposure, even though a child has a late age of onset, they may become fluent enough to be recognized as a native speaker (Unsworth et al. 2014, Pfenninger & Singleton 2019). Several authors notice, however, that achieving native-like proficiency is, in fact, rather difficult for children with a late age of onset (Johnson & Newport 1989). There is no straightforward conclusion as to whether native-likeness is possible or not with a late age of onset, and there have been many debates over whether there is a crucial timeframe for the learning of a second language to happen in a native-like manner (Clahsen & Felser 2006). Pronunciation appears to be a particularly challenging domain for children with a later age of onset, and several studies have tried to address this problem.

In a large-scale study, Abrahamsson & Hyltenstam (2009) investigated a sample of Spanish/Swedish bilingual adults and found that none of them spoke English without a detectable foreign accent when measured with pronunciation tests. However, when assessed by human raters, some of the late age of onset participants in their sample were recognized as natives. As the authors conclude, attaining native-like mastery in a second language is feasible or even normal in certain situations, namely where exposure is very high and immersion is total, but these conditions are not common (Abrahamsson & Hyltenstam 2009). In other words, it is possible to become fluent and be perceived as native-like even when the onset is late, but prevalence analyses show that this situation is very rare, and that speakers with an early age of onset have an easier time attaining proficiency.

A study by Moyer (1999) focused on pronunciation of speech elicited with a variety of different methods, including reading. For the study, she

recruited 24 highly skilled American university students who were studying in Germany and who were assessed on: Word-list reading, sentence reading, essay reading, and elicited free speech. The students' pronunciation was then evaluated by four native German speakers. Several participants were able to be recognized as native speakers in one of the four activities, word-list reading. In the other three, however, the majority of participants did not reach a native-like level. Just one of the 24 participants completed all four assignments successfully. Among other findings, Moyer's research uncovers an important aspect in the study of second language pronunciation: Findings tend to be less reliable when assessing free speech production, because by definition speakers are free to use words that belong to their repertoire. Assessing accuracy while reading, instead, offers a system for a more controlled environment, where the target phonemes are the same for all participants.

Along these lines of thought, Kovelman, Baker & Petitto (2008) conducted a study on reading in Spanish/English bilingual children. Their study's aim was to determine whether age of onset predicted reading skills attainment in primary school. The study focused on students in bilingual schools, which offered two groups of participants: English speakers exposed to Spanish from monolingual English-speaking homes and Spanish speakers exposed to English from monolingual Spanish-speaking homes. The study showed that bilingual children with an early age of onset outperformed bilingual children with a later age of onset, and this applied to both languages used for assessment. Additionally, English speaking children from monolingual homes outperformed the control group of monolingual children in English-only schools in tasks on phonological awareness, but they did not on the reading task (Kovelman, Baker & Petitto 2008). The authors concluded that attending bilingual schools, and hence experiencing an early exposure to multiple phonemic systems, aided children from monolingual homes in developing phonological skills, and that among the bilingual groups, those with an early age of onset are the only ones that reached native-like performance in their second language reading. The general conclusion is that age of onset does matter when learning a second language, especially when it comes to phonology and reading skills.

The current study develops these ideas and relies on a similar methodology to assess whether age of onset to English has an effect on the development of reading skills in Czech children.

## 2 Differences between Czech and English phonemes

There are some major differences between the Czech and English phonological systems, and this is one of the reasons why it is difficult for Czech learners to speak English with a standard English pronunciation. Both vowels and consonants vary across these languages, with the differences with vowels being particularly important. Vowels and consonants will be discussed in the next segment separately. We will start from consonants: Table 1 presents the consonants used in Czech language and Table 2 presents the consonants used in English.

		place of articulation						
		bi-labial	labio-dental	alveolar	post-alveolar	palatal	velar	glottal
manner of articulation	nasals	m	(m̥)	n		ɲ	(ŋ)	
	plosives	p b		t d		c ʃ	k g	(ʔ)
	affricates			ts dz	tʃ dʒ			
	fricatives		f v	s z	ʃ ʒ		x (χ)	h
	trills			(r̥) r̥				
	lateral			l				
	approximants (w)					j		

Table 1: Czech consonant system

		place of articulation							
		bi-labial	labio-dental	dental	alveolar	post-alveolar	palatal	velar	glottal
manner of articulation	nasals	m	(m̥)		n			ŋ	
	plosives	p b		θ ð	t d			k g	ʔ
	affricates					tʃ dʒ			
	fricatives		f v		s z	ʃ ʒ			h
	lateral				l				
	approximants w					r	j		

Table 2: English consonant system

The first noticeable distinction to be observed is that there are no phonemes in Czech that can be articulated in the dental position. This means that native Czech speakers, in addition to the phonemes that are part of their repertoire, need to master the consonants /θ/ and /ð/ when learning English. These are two of the most troublesome phonemes for Czech speakers, as these speakers naturally do not make any sounds with that specific place of articulation. Table 1 shows that, right next to the

dental phoneme column, there is an alveolar phoneme column. There it can be seen that alveolar affricates ( $/\widehat{ts}/$  and  $/\widehat{dz}/$ ) are found only in Czech and not in English. The  $/\widehat{ts}/$  and  $/\widehat{dz}/$  sounds can sometimes occur in the English speech of a Czech learner when they are not sure how to pronounce certain words. Similarly, the sounds  $/x/$ ,  $/c/$ ,  $/ʃ/$ ,  $/ɦ/$  and  $/ɲ/$  are specific to Czech and not English, and can sometimes appear when Czech speakers do not know how to pronounce certain words correctly (Černá, Ivanová & Myslivec 2017). The phoneme  $/ɦ/$  is mentioned as typical for the Czech consonant system. This phoneme is classified as a glottal fricative, and its counterpart in English is the phoneme  $/h/$ ;  $/h/$  can be found in the same space in the table of English consonants and that is because  $/ɦ/$  is voiced and  $/h/$  is devoiced, but both are glottal fricatives. Learning to devoice this sound is generally not a big issue for Czech speakers and it does not cause significant problems of pronunciation (Černá, Ivanová & Myslivec 2017). The last difference in the consonant system is the pronunciation of the letter “r”. While in English, the letter “r” is pronounced as a post-alveolar approximant  $/r/$ , in Czech, there are several sounds that correspond to the letter “r”, all to be found in the spot of alveolar trills ( $/r̝/$   $/r̞/$   $/r/$ ). Trills are not part of the English consonant system, but Czech speakers are accustomed to this sound and may be likely to use it in place of a post-alveolar approximant when speaking or reading English (Šimáčková, Podlipský & Chládková 2012).

Despite these important differences between the Czech and English consonant system, even more important variations can be found in the chart of vowels, as seen in the following figures. Figure 1 reports the quadrilateral for Czech and English vowels.

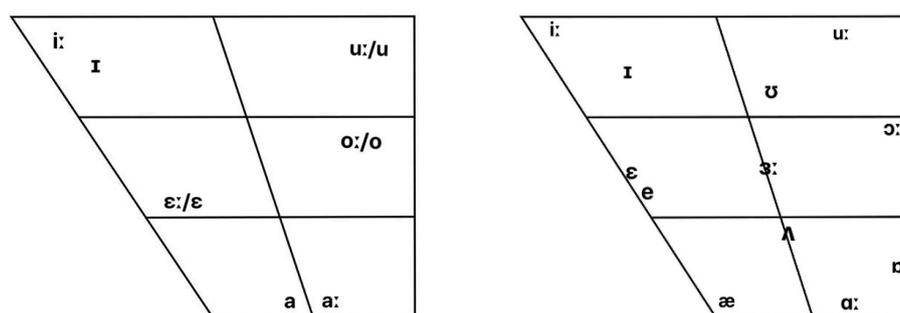


Figure 1: Czech vs. English vowel system

As it can be seen, there are only seven possible positions in the Czech quadrilateral where a vowel can be pronounced and there are three pairs of long-short vowels (those are pronounced in the same place, the only difference is length). Given this, if these pairs of short and long vowels

are counted as one, it can be assumed that there are four vowels in Czech that cannot be found in English. Similarly to what happens to Czech consonants, these vowels are also used by Czech speakers when they are uncertain of the proper pronunciation of an English word (Černá, Ivanová & Myslivec 2017). On the other hand, there are nine vowels in the English system that are not naturally acquired when exposed to Czech. This very large asymmetry is extremely problematic for Czech learners of English and it may take a lot of time and preparation for Czech speakers to learn how to utter these vowels according to standard English (Skarnitzl & Rumlová 2019).

### **3 Types of errors observed in second language reading studies**

A number of studies addressed the issue of which errors children make when reading in their second language. Classic work from Czikó (1980) on English speaking children reading in French shows that proficiency in L2 is a main predictive factor on the nature of these errors. Lower proficiency does not uniquely lead to a higher number of mistakes, but also to mistakes of a different nature: while more proficient speakers tend to make fewer mistakes and these tend to be minor mispronunciations, lower proficiency speakers tend to add or omit phonemes, or they tend to switch words with graphic neighbors (for example reading “house” as “has”). Subsequent work has showed how these errors are influenced by the orthographic complexity of the language in object. English and French are both semi-opaque, but what happens if English as L1 is paired with a transparent L2? Geva, Wade-Woolley & Shany (1993) addressed this problem and compared decoding mistakes in children that read English as L1 and Hebrew (when written in its transparent script) as L2. The results showed that decoding mistakes were mitigated in L2, suggesting a fundamental role of transparency of the writing system as a predictor. Interestingly, subsequent analyzes of the same dataset (Geva, Wade-Woolley & Shany 1997) show that reading in L1 was facilitated when target words were part of a text, while this was not the case in L2, indicating a purer decoding in L2, and more top-down processing in L1. Consistent findings were obtained by Verhoeven (2000), who showed that decoding in Dutch (a transparent language) by L1 and L2 children leads to comparable results, even though comprehension tends to be lower in L2 readers. Once again, consistently with these claims, Lervåg & Aukrust (2010) showed that early decoding skills are not a strong longitudinal predictor of reading comprehension in Norwegian (a transparent language), while vocabulary skills are. This finding suggests

that when reading a transparent L2, variation in decoding skills will not have an important role because all children will achieve relatively high decoding accuracy. As Verhoeven, Perfetti and Pugh (2019, p.5) explain in a recent review on this topic, “although similar [to those recruited for the L1] brain areas are involved at high levels of L2 reading skill, differential computational demands may apply to learning an L2 that likely involves specific brain reorganization of language, reading and control networks”. In other words, when a second language differs in terms of level of orthographic depth, early stages of learning may require very different processing strategies, that only after many years will converge to native-like processing. As Bassetti (2008) explains, different orthographic systems can lead to reading errors, and this is particularly true for mispronunciations. When the target script is partially opaque, readers are more likely to resort to L1 representations and use thus phonemes they are more familiar with.

The current study is the first to analyze this complex interaction in Czech native speakers that are reading in English. This pairing of languages is interesting because it addresses the learning of decoding strategies in a semi-opaque language (English) when the baseline native language uses a very transparent orthography (Czech).

## 4 Research questions and hypotheses

The examination of previous work on this topic has showed that there are various factors affecting accurate reading in second language in children. Particularly, these studies have shown that different kinds of errors may be observed, and that the nature of the scripts involved may affect the nature of these errors. Additionally, these studies showed that proficiency and ages of onset can influence the results as well. This study aims thus at exploring these issues in a pair of previously uninvestigated languages. The research questions that we aim at addressing with this study are:

1. What type of errors do children make when they read in English and their first language is Czech?
2. To what extent the type of errors made are modulated by the age of first exposure to the second language?

Based on the literature showing the importance of age of onset for the development of native-like phonology, and based on the important differences in the phonological systems of Czech and English, we expect children to perform a large number of phonological errors while reading (particularly mispronunciations), and we expect these errors to be modulated by age of onset and be more prominent in children with a later

age of onset.

## 5 Methods

The project was submitted to the ethics committee of our university and it received favorable opinion. Children were then recruited in a primary school in Rokycany, after the head of school gave their approval. Parents were given a consent form and an information sheet, and only children whose parents gave approval were involved in the study. Consent forms are now stored in a locked cabinet and will be kept there for the next five years. No personal information is associated to the collected data. No individual results are presented in this article. Data for this study were collected as part of the thesis of one of the authors of this article (Skočilová 2020), and some sections of the text appeared in her thesis. This procedure is allowed by our university.

In this study, a standardized reading task was used to measure reading skills in two groups of Czech-English children. We used a standardized test for two reasons: 1. Since this test includes a placement pre-test, it ensured that participants were exposed to a text that was suitable for their level of English. 2. The use of a structured test meant that each participant is exposed to the same texts as the other participants (when they have the same level of proficiency), making the findings comparable (both within our study, but also comparable to the large body of data analyzed by the community more in general).

The chosen test is the York Evaluation of Reading for Comprehension Passage Reading, created by Margaret J. Snowling, Susan E. Stothard, Paula Clarke, Claudine Bowyer-Crane, Angela Harrington, Emma Truelove, Katie Nation and Charles Hulme (Snowling et al. 2009). A manual, a form with several texts for the participants, a record form, and a single word reading task make up this assessment.

As instructed by the manual, we used the single word reading task to assess the starting text for each child. The single word reading task consists of sixty items separated into six categories based on how difficult they are to read and pronounce: Children were asked to read all the words they could without any help. If they could not read a word, they were asked to move on to the next one. They were given the option to try to read all of the words, but if the challenge turned out to be too difficult or stressful, they were allowed to stop. The cumulative number of correctly pronounced words was then determined, and an experimental text was allocated to each person on the basis of this final number.

In the YARC, there are seven distinct texts varying in difficulty. The

<b>Single Word Reading Test (SWRT) Raw Score</b>	<b>Starting passage level</b>
Below 19	Beginner Level
19-24	Level 1
25-30	Level 2
31-37	Level 3
38-41	Level 4
42-47	Level 5
Above 48	Level 6

Table 3: Single word reading task conversion

first text was designated as a "beginners' text," and the other six were numbered, with text 1 being the simplest and text 6 being the most difficult. The appendix includes the content of one of these texts (as an example, we included text 2 because it was read by a significant number of participants). After being given the assigned text, each subject was asked to read the text as well as they could without assistance. Any errors were reported on a record sheet, and the errors were then counted. Following the completion of the first text, the participant was asked to read one more file, either of a higher or of a lower level, based on the number of errors. To test comprehension, participants were asked to answer eight questions about the text they just read. Since an assessment of comprehension was not among the aims of this article, this measure was not included in the data analysis. However, after the completion of the first reading, a relative measure of the child's comprehension of the text was helpful in determining whether to move to a higher or to a lower text level. Finally, participant's reading speed was recorded and compared to pre-determined benchmarks, as suggested in the assessment manual. A short questionnaire was also provided to the participants, in which they answered questions about their identity, age of onset to English, and attitude to learning English. The whole meeting was recorded. We then used the International Phonetic Alphabet (IPA) to write down the erroneous pronunciations, and then categorize them into five groups, as indicated in the YARC manual: substitutions, mispronunciations, refusals, additions and omissions.

## 6 Results

Descriptive statistics (mean and standard error) for all types of decoding errors across the two groups are presented in Table 4 below.

	Kindergarten-onset children	School-onset children
Substitutions	3.2 (0.6)	6.1 (0.7)
Mispronunciations	23.95 (1.6)	22.9 (1.9)
Refusals	1 (0.6)	0.6 (0.2)
Additions	0.21 (0.1)	0.35 (0.1)
Omissions	0.35 (0.2)	0.7 (0.2)

Table 4: Descriptive statistics (mean and standard error for each condition)

Substitutions and mispronunciations composed by far the most common types of errors and are the only types of error with a mean per participant above 1. For this reason, we decided to focus the analysis on these two kinds of errors only. An inspection of the dataset with histograms showed that data was skewed to the right. We then applied a transformation to the data using inverse square root, which led to an approximate normal distribution of the dataset. Data were then analyzed with a 2x2 Anova, having a) *group* and b) *type of error* as predictors. The analysis shows a highly significant main effect of type and a significant interaction between group and type, while the main effect of group did not reach the threshold for significance. The results are summarized in Table 5 and presented visually in Figure 2.

Source of Variation	SS	df	F	P-value
Group	1.87	1	2.54	0.11
Type of error	157.6	1	214.09	< .001 **
Interaction	4.13	1	5.61	.02 *

SS – sum of squares, df – degrees of freedom, F – test statistic, P – probability

Table 5: Anova results

The significant main effect of type shows that mispronunciations were considerably more frequent than substitutions in both groups ( $p < .001$ ). Groups appeared to not differ overall in their performance ( $p > .05$ ), even though the significant interaction between type and group ( $p = .02$ ) indicates that the gap between substitutions and mispronunciations is different in relation to the two ages of onset. Post-hoc t-tests show that, indeed, school-onset children made a larger number of substitutions than kindergarten-onset children,  $t(38) = -2.85$ ,  $p = .006$ . Other post-hocs did not reach significance, indicating that the significant

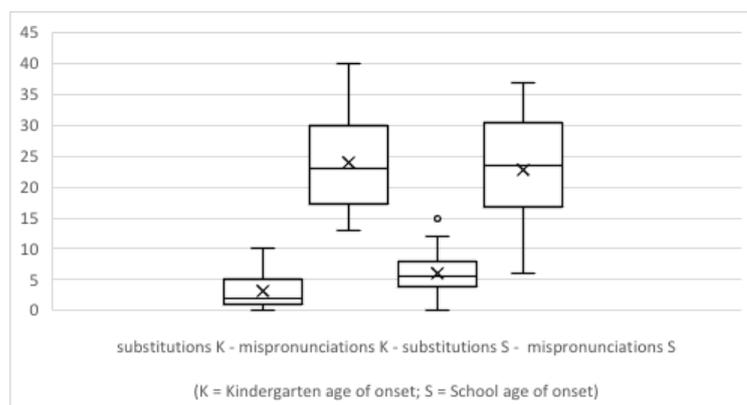


Figure 2: Boxplots for number of substitutions and mispronunciations in the two groups

interaction is driven by this contrast. Consistently with these results, the effect size is large for the type factor ( $\eta^2 = .64$ ), small for the interaction ( $\eta^2 < .018$ ) and negligible for the group factor ( $\eta^2 < .008$ ), according to Cohen's guidelines (Richardson 2011).

## 7 Discussion

The goal of this research was to explore the nature of the errors made by Czech children when reading in English and understand to what extent these errors are modulated by the age of first exposure to English. The study was performed on 40 Czech children learning English aged between 8 and 12, divided in two groups: one with kindergarten age of onset (i.e., children exposed to English since age 3), and another with a primary school age of onset (i.e., children exposed to English since age 6). A preliminary count of errors showed that only substitutions and mispronunciations occurred on average more than once, so we focused our analysis on these kinds of errors. Our results show that mispronunciations were overall more frequent than substitutions<sup>1</sup>, and that age of onset did not overall affect performance, with groups scoring similarly. However, there was a significant interaction between type of error and age of onset, and when substitutions were compared with post-hocs, kindergarten-onset children outperformed school-onset children. This

1. The possible reasons leading to this overwhelming majority of mispronunciation errors are presented in the second part of the discussion.

finding is in line with previous literature:

Generally speaking, previous work has shown that age of onset is an important predictor for second language acquisition, whether this happens during childhood or after, and the earlier a person begins to learn a language, the more successful they will be (Clahsen & Felser 2006, Meisel 2010)<sup>2</sup>. This includes success rates for pronunciation, a subdomain that is closely related to reading and that appears to be particularly sensitive to age of onset effects (Abrahamsson & Hyltenstam 2009). Similarly, previous work addressing specifically the ability to read showed that only children with an early age of onset tend to achieve native-like performance in primary school (Kovelman, Baker & Petitto 2008), a finding with important practical and ethical implications.

Based on these studies, the prediction we outlined regarding age of onset was then that, out of the two groups (kindergarten vs. school age of onset), the former would have been facilitated in reading English text. This prediction was confirmed when it comes to the count of substitutions. Substitution of a word for a different word while reading can usually be explained as a strategy the child employs if decoding is too difficult. Usually, substitutions consist in the production of a word that is partly phonologically related to the target word but does not share all phonemes (such as “house” for “has”). For Czech children reading in English, the problem is related to the different writing systems: while Czech is a very transparent system, English is a semi-opaque system (Caravolas, Volín & Hulme 2005). There are some major differences in reading these two languages. Generally, there are two procedures a reader adopts when decoding a Latin alphabet. These two procedures, first described by Coltheart et al. (2001) in the dual route model of reading, are summarized below:

The grapheme-phoneme route transforms individual symbols into specific phonemes. For example, when reading Czech, the symbol “k” is transformed into /k/. The lexical route, on the other hand, takes a word as a unit and a specific sequence of sounds is assigned to this unit; this set of sounds may or may not correspond to the specific graphemes used in the written version of the word (i.e., the word would not be read correctly if the grapheme-phoneme route was used instead). For example, the sequence of symbols “ough” in English receives different

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2. See however Birdsong (2018) for a discussion of age of onset and its potential role as a confounding variable. In short, while it is true that early onset children tend to achieve higher levels of proficiency, this is often related to the fact that these children have a higher motivation to learn a second language or that the second language is particularly useful or important in their social context. Late L2 learners can still achieve very high levels of proficiency when these conditions of motivation and social importance are met, suggesting that age of onset effects are not necessarily related to maturational constraints of the mind/brain.

pronunciations depending on the word it belongs to, and cannot thus be read by simply transforming each symbol into a phoneme. The first route is the one used more heavily by Czech speakers, since Czech has an orthography that is phonetically transparent, so it is the route that is taught to Czech children in schools. However, since English uses heavily the other route as well, reading in English may cause problems for Czech speakers of English (Verhoeven, Perfetti & Pugh 2019). Interestingly, because of the two very different routes, previous work shows that the easiest way to learn how to read English for a Czech learner includes transcribing opaque words with a grapheme-phoneme system (Škopová 2017). For this purpose, special notebooks are available in Czechia for writing down English vocabulary. These notebooks contain three columns: one for the English word, one for the Czech translation and a third one for the pronunciation. Teachers either write down an approximate pronunciation using the Czech grapheme system, or they train their students with IPA (the international phonetic alphabet). In other words, for the initial stage of learning, the grapheme-phoneme route is used; once the right pronunciation settles, children learn to use the lexical route to memorize the appearance of the word as a whole.

Readers can make mistakes in either of these two routes. If children make a mistake pronouncing a certain specific phoneme, they are making a mistake in the grapheme-phoneme route; if they read a completely different word than the one that is written down in the text, the mistake is happening in the lexical route. This distinction is important because it may help to interpret the substitution and mispronunciation errors observed in the current sample:

Late onset children display a larger number of substitutions in comparison to early onset children. The different number of substitution errors in the two groups might indicate an effect of acquaintance with the lexical route: The ability to use appropriately the lexical route is something that needs to be learned with practice, and early onset children might have crucially been exposed to English long enough to be more acquainted with its lexicon. This claim is consistent with previous work showing that lexical knowledge (rather than visual decoding skills) tends to be the most reliable predictor of accuracy in second language reading (Lervåg & Aukrust 2010), potentially showing that these effects are not limited to comprehension but also to decoding accuracy.

Importantly, we are suggesting that a smaller number of substitutions in the early onset children has nothing to do with education, but possibly with a larger familiarity with the English lexicon, which allows for a better use of the lexical route when reading. The teaching of English (both in English speaking countries and abroad) to children often does not focus on whole word reading explicitly (lexical route), but it rather focuses

on grapheme-phoneme conversion. In the UK, for example, children undergo a learning phase described in the education sector with the term “phonics”, which happens in the early stages of reading learning (Ehri et al. 2001). In this stage, children are taught the general rules on how to transform a grapheme into a phoneme. This step is very useful not only in learning to read a transparent language, but also in learning to read semi-opaque languages such as English, because it allows children to “crack the code”, read correctly some of the words (the transparent ones), and have some intuition on opaque words as well. For example, using grapheme-phoneme conversion, the word “house” would be read /hʌʊse/, but this sequence is close enough to the target for the child to start using the lexical route automatically, and retrieve thus the correct target /haus/. Thus, the advantage of early onset children in terms of substitutions may not be attributed to classroom teachings, but rather to a larger familiarity with the English lexicon: due to this familiarity, once early onset children start reading words, it is easier for them (in comparison to late onset children) to access the target one, and they are less keen on resorting to a different word.

On the contrary, the large number of mispronunciations in the entire sample indicates that a kindergarten age of onset is not sufficient for children to develop autonomous phonological systems. This finding is again in line with previous work, particularly with the claims of Bassetti (2008) on the role of the interaction between L1 and L2 orthographies in decoding accuracy. When children used to a transparent orthography are presented with a semi-opaque orthography, there are many chances that they will resort to the phonological representations of L1 when reading items they are not sure about. As such, Czech children reading an English script are likely to mispronounce many words, over-relying on or over-using phonemes that belong to Czech or that are used when decoding a specific letter (when reading in Czech). As described in the introduction, the phonological systems of Czech and English differ in some crucial features, both in terms of consonants and vowels (Šimáčková, Podlipský & Chládková 2012). The large number of mispronunciations observed indistinctly in both early and late onset children in this sample indicate that while children are close to their target words in terms of decoding, they fail to retrieve or articulate the right phonemes when pronouncing these words. As mentioned in the introduction, a large body of evidence indicates that the development of a native-like phonological system requires either a very early age of onset, or a very substantial immersion (Kovelman, Baker & Petitto 2008, Birdsong 2018). Our findings fit well with these claims, and show that an age of onset of 3 is not sufficient for children to develop native-like phonology in their L2, especially when exposure only occurs for a limited number of hours in the educational

context. Mispronunciations are thus equally observed in children with an onset of 3 and an onset of 6. Previous work has shown a number of different phonological errors in children reading in their second language (Geva, Wade-Woolley & Shany 1997, Verhoeven 2000, Lervåg & Aukrust 2010), but the pairings in these studies were not usually a transparent L1 and a (semi) opaque L2, so these studies are not easy to compare to the current one. The current research offers a glance into an understudied pair of languages (Czech + English), adding pieces of evidence that fill a rather specific gap: Czech is a Slavic language with a very transparent orthography that is written using the Latin alphabet (Caravolas & Volín 2001). Contrary to studies comparing English and the widely used Russian, Czech offers a more controlled experimental condition where the only difference between the orthographies of L1 and L2 is the level of opacity. While there are studies of this kind that pair English with Romance, Germanic or Semitic languages, this is the first study, to our knowledge, to do it with a Slavic language. Our findings extend claims previously made for different pairs of languages (particularly the claim that readers familiar with a transparent language tend to produce many mispronunciations when presented with an opaque one, see Bassetti 2008), adding to the picture a study with an extremely transparent L1 (Caravolas & Volín 2001).

Together, these findings offer a nuanced picture of second language reading skills in Czech children with different ages of onset to English. On the one side, pronunciation errors seem to affect the entire sample, possibly due to the fact that an onset of age 3 is not sufficient to develop native-like phonology, either because it is too late, or because immersion in kindergarten is not intensive enough. This finding is consistent with previous work on children that are learning to read in an opaque L2 and are familiar with a transparent L1. On the other side, the earlier age of onset corresponds to a smaller number of substitutions, indicating possibly a better grasp of the lexicon used in children's literature, and thus a more efficient use of the lexical route while reading. Further research in samples with children with an earlier age of onset and/or with different levels of immersion may help better refine these claims.

## Appendix

The robin is a bird with a bright red face, neck and breast. You can find it in gardens, parks and woods all year round.

Robins make their nests in a hole in a tree stump, bank or wall. Sometimes they nest in pots, or even the pockets of an old coat. Their eggs are pale with reddish spots.

Figure 3: Example of text from the York Assessment of Reading & Comprehension (Snowling et al. 2009)

## Ethical concerns

Research involving human participants: This study does involve human participants.

Informed consent: This study was carried out in accordance with the recommendations of [removed for review] Ethics Committee with written informed consent. Parents gave written informed consent in accordance with the Declaration of Helsinki. This study is part of the project [removed for review] which was evaluated by the ethics committee of our university and was given favorable opinion.

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