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DIPLOMOVÁ PRÁCE

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Nonword repetition in bilinguals. Does performance differ from Developmental Language Disorder?

Opakování pseudoslov u bilingvních dětí. Liší se výsledky ve srovnání s dětmi s vývojovou poruchou jazyka?

Praha 2020 Vedoucí práce: Luca Cilibrasi, Ph.D.

I would like to thank my supervisor Luca Cilibrasi, PhD. for allowing me to explore the field of language acquisition research with this thesis. I would also like to thank him for his assistance, invaluable comments, and patience, which all helped me greatly in finishing this work.

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This study investigates the patterns in nonword repetition performance of children with a developmental language disorder and bilingual children. It has been shown by previous research that both children with developmental language disorder and bilingual children tend to perform poorly in nonword repetition tasks. As these tasks are one of the tools often used for diagnosing markers of DLD in young children, diagnosing bilinguals with DLD proves to be difficult, since both of the groups exhibit a poor performance. An analysis of the patterns found in NWR performance of bilingual children and children with DLD might shed more light onto the issue. The study focuses on analysing the performance in a widely used assessment task – The Children's Test of Nonword Repetition. Three samples of data were analysed. The first sample of data consisted of monolingual English-speaking children diagnosed with a developmental language disorder. The second sample of data consisted of Czech-English bilingual children from international schools in Prague who started acquiring English at the time of birth, i.e. simultaneous bilinguals. The third and final sample consisted of Czech-English bilingual children from international schools in Prague who started acquiring English after one year of age, i.e. sequential bilinguals. The items of the CNRep task were divided into categories and were subsequently analysed. Two models for a statistical analysis were created. For the first condition of the study, the items were divided into four categories based on nonword length (2, 3, 4 and 5 syllable nonwords). For the second condition, 4 and 5 syllable nonwords were further divided into items that did and did not contain a noninitial cluster. The results obtained in this study were mixed. A similarity was found in certain patterns of performance of DLD children and sequential bilinguals. Both of the groups showed an effect of length in longer nonwords, and both of them appear to be negatively impacted by the presence of clusters, independently from the length of the nonword. Simultaneous bilinguals showed a contrasting pattern, as they were influenced by length only in shorter nonwords, and the effect of cluster was not as clear cut in their performance. Therefore, the age of onset of the second language seems to be the determining factor in whether looking at patterns in nonword repetition performance might disentangle the effects of DLD and bilingualism.

Keywords: bilingualism, bilingual acquisition, child bilingualism, language acquisition, phonological acquisition, age of onset, simultaneous bilingualism, sequential bilingualism, nonword repetition, developmental language disorder

Tato práce se zabývá výkonem bilingvních dětí a dětí s vývojovou poruchou řeči v testech opakování pseudoslov. Předchozí výzkum ukázal podprůměrné výsledky jak u bilingvních dětí, tak dětí s vývojovou poruchou řeči. Opakování pseudoslov se běžně užívá jako diagnostický nástroj pro odhalení vývojové poruchy řeči u dětí. Metodou opakování pseudoslov je tak možné odhalit vývojovou poruchu řeči u bilingvních dětí jen s obtížemi. Tato práce se pokusí o hlubší analýzu výkonu bilingvních dětí a dětí s vývojovou poruchou řeči v běžně užívaném testu – The Children's Test of Nonword Repetition (CNRep). Prozkoumány byly tři skupiny dat. První skupinu tvořily monolingvní anglicky mluvící děti s diagnózou vývojové poruchy řeči. Druhá skupina sestávala z bilingvních dětí (čeština/angličtina), které se učí angličtinu od narození (tj. simultánně bilingvních). Třetí skupinu tvořily bilingvní děti (čeština/angličtina), které se začaly učit angličtinu po jednom roce života (tj. sekvenčně bilingvní). Položky testu CNRep byly rozděleny do kategorií a následně analyzovány. Byly vytvořeny dva modely pro statistickou analýzu. Pro první model byly položky rozděleny do čtyř kategorií na základě délky pseudoslova (2, 3, 4 a 5 slabičná pseudoslova). Pro druhý model byla 4 a 5 slabičná slova dále rozdělena na položky obsahující a neobsahující shluk souhlásek v jiné než první slabice slova. Výkon dětí s vývojovou poruchou řeči a sekvenčně bilingvních dětí vykazoval určité podobnosti. Obě skupiny se nejhůře potýkaly s nejdelšími slovy v testu. Ukázalo se také, že slova osahující shluk souhlásek byla pro obě skupiny obtížnější bez ohledu na délku pseudoslova. U simultánně bilingvních dětí se projevila odlišná tendence, neboť jejich výkon délka slova ovlivnila pouze u kratších pseudoslov. Rovněž efekt shluku souhlásek neměl tak zásadní vliv na jejich výkon. Hlubší analýza výkonu (zejména s ohledem na délku a shluk souhlásek) v testech opakování pseudoslov by tak mohla být přínosná u simultánně bilingvních dětí, ne však u sekvenčně bilingvních.

Klíčová slova: bilingvismus, bilingvní osvojování jazyka, dětský bilingvismus, osvojování jazyka, osvojování fonologie, simultánní bilingvismus, sekvenční bilingvismus, opakování pseudoslov, vývojová porucha řeči

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LIST OF ABBREVIATIONS

BIDLD – Bilingual child with a Developmental Language Disorder

CNRep – The Children's Test of Nonword Repetition

DLD – Developmental Language Disorder

L1 – First Language / Mother Tongue

L2 – Second Language

LMEM – Linear Mixed Effects Model

LTM – Long Term Memory

NWR – Nonword Repetition

PWM – Phonological Working Memory

PLI – Phonological Language Impairment

SLI – Specific Language Impairment

STM – Short Term Memory

TD – Typically Developing

UG – Universal Grammar

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INTRODUCTION

Nonword repetition is often used in assessing language skills of children. A nonword repetition task comprises of a number of made-up words built to resemble the phonetic features of a chosen language (i.e. the mother tongue of the assessed subject). The child is presented with a made-up word and is subsequently tasked with repeating said made-up word accurately. Nonword repetition assesses the phonological abilities of a child, such as the ability to perceive and produce phonemes, as well as the child's short-term working memory (in other words, their ability to store and reproduce unknown phonemic sequences). A number of standardized nonword repetition tests has been developed over the years and these tests have consistently been used in both experimental and clinical settings. In clinical settings, nonword repetition serves as of the tools for determining markers of a developmental language disorder in children, as it can uncover certain struggles the children might be dealing with. The children exhibiting signs of a developmental language disorder tend to perform below average in nonword repetition tasks. This poor performance is caused by processes needed to perform the task successfully. A problem arises when these standardized tasks are used to assess children coming from other than monolingual backgrounds, as the tasks were designed with a purely monolingual acquisition in mind. The scoring and evaluation of the tests do not accommodate children coming from multilingual backgrounds.

To understand the problematic nature of monolingual-centred testing, it is crucial to look at the process of language acquisition and its stages of development. We can find several approaches to the complex issue of what enables children to learn a language. It is, however, clear that monolingual acquisition follows certain patterns across languages and across individual children (= acquisition of linguistic features happens at a similar rate in all children, regardless of their mother tongue and regardless of the quality and type of input they receive). The theoretical framework of the present study will examine in more detail the timeline and the specifics of phonological acquisition processes that need to be understood in order to discuss nonword repetition tasks and their implications in both monolingual and multilingual children.

A great number of research has proven that bilingual acquisition does not mirror exactly the timeline of monolingual acquisition. There are certain specifics that pertain to multilingual acquisition. As has been shown by numerous research, certain processes of acquisition in bilinguals can be delayed as opposed to their monolingual peers. It would, however, be overly simplistic to claim that bilingual acquisition merely happens at a slower rate. Bilinguals exhibit different patterns of development in both linguistic and cognitive domains. Bilinguals have even been shows to outperform their monolingual counterparts in a variety of linguistic and cognitive assessments. The specifics of bilingual development will be thoroughly discussed in the theoretical background of the present study. When acknowledging that the language acquisition of bilingual children follows a different pattern than the language acquisition of monolingual children, it is also evident that bilinguals are bound to exhibit different patterns when assessed with monolingual-centred standardized tests. This proves to be the case for nonword repetition.

We have circled back to the question of nonword repetition assessment of children coming from bilingual backgrounds. Bilingual children tend to perform below average in nonword repetition tests. As was already mentioned, another group that tends to perform below average on nonword repetition tests are children exhibiting signs of a developmental language disorder. Thus, a problem arises when we attempt to diagnose bilingual children with said disorder. Oftentimes, bilingual children face an incorrect diagnosis of a developmental language disorder due to their below average performance in assessment tasks. On the other hand, serious issues bilingual children could be facing may be overlooked and dismissed purely as marks of bilingualism. Recently, a number of researchers have started delving more into the question of bilingual nonword repetition performance. A variety of studies suggests that a nonword repetition accuracy score in one language is not a sufficient marker of a developmental language disorder in bilingual speakers. Regardless, given as nonword repetition is widely used in clinical settings, it is important to try and understand the specifics of bilingual performance in these types of tasks.

The aim of the present study is to analyse more closely nonword repetition performance of bilingual children, as well as the performance of children with developmental language disorder. The study will attempt to search for patterns in the nonword repetition performance of these two groups. The study will attempt to understand whether the patterns found in the performance of bilingual children and children with a developmental language disorder differ substantially. The possible difference in patterns found in the performance of these two groups could shed more light onto the issue of disentangling the effects of bilingualism and the effects of a developmental language disorder in below average nonword repetition performance.

THEORETICAL FRAMEWORK

The following chapter will provide a background leading to the present study. The chapter will firstly discuss the phenomenon of child language acquisition with a focus on phonology, along with tests used to assess phonological development. Then, the phenomenon of bilingualism and bilingual acquisition with a focus on phonology will be presented. Finally, the chapter will conclude with a section on developmental language disorder (DLD) and its interference with bilingualism.

1. CHILD LANGUAGE ACQUISITION

To provide a basis for the present study, this chapter will briefly introduce the domain of child language acquisition. As Guasti (2016) says, human language acquisition is an astonishing process. In children, the acquisition of such a complex skill as a fully developed system of communication occurs effortlessly – without an explicit teaching process. Moreover, language acquisition follows substantially similar steps across various languages, with minor effect of the type and amount of input the individual child receives (including varying degrees of child-directed speech) (Guasti, 2016; Ambridge & Lieven, 2011).

Several theoretical explanations of language acquisition have been proposed in the last decades. Mostly, the theories are aligned with one of two major approaches. (a) Nativist / generativist / Universal Grammar approach (Ambridge & Lieven, 2011) claims that some aspects of linguistic knowledge are innate – i.e. present from birth. Contrastingly, the (b) constructivist / emergentist / socio-pragmatic / functionalist / usage-based approach (Ambridge & Lieven, 2011) assumes that humans do not have an innate knowledge of grammar and that linguistic abilities are rather acquired via generalizing the input children receive from adults. Within each of these major approaches to language acquisition, one can find varying sub-theories, which oftentimes largely differ from one another. The theories will be further discussed below.

Looking firstly at a theory called the *innateness hypothesis* (a), one can observe both a milder and a stronger approach being employed. In its mild form, the innateness hypothesis claims a predisposition for language, resulting ultimately in the ability to combine forms into higher units (Hauser, 2002). The stronger version, on the other hand, assumes an innateness of grammar as such (the theory of Universal Grammar). With Chomsky as pioneer of the theory, Universal Grammar claims that children are born with a system of structured knowledge which specifies the linguistic rules and possible variations (for example grammatical and lexical categories), essentially suggesting that linguistic knowledge is encoded in our DNA. According to UG, DNA contains instructions on how to build a human body, therefore grammar may be included in the information reserved for building language specific areas of the brain (Chomsky, 1981). Several theories are, however, critical of these claims (b). One of the constructivist approaches suggests that children acquire language on the basis of imitation – repeating the input they have received from adults. Another major theory (Skinner, 1957) claims that we learn through reinforcement – we are positively reinforced when we produce a correct form and negatively reinforced when we utter something incorrectly.

Another hypothesis belonging to the constructivist approach, developed by Tomasello, which focuses on learning through analogy, claims that children acquire language through generalization (a process in which children derive and store new forms based on analogies of inflected forms they are familiar with). Tomasello (2003) proposes that children develop language skills through their abilities of finding patterns and reading intentions – in the speech they perceive, children assess patterns, as well as goals and intentions of other speakers and therefore they learn the necessary linguistic conventions through a cultural lens. Rather than relying on the existence of a specialized innate system of grammar, Tomasello (2003) argues that language learning in children is intertwined with other cognitive abilities.

Both of these major approaches to language acquisition (generativist and constructivist) rely heavily on the debate surrounding a notion called *critical period.* The concept of critical period will be further discussed below. The debate surrounding critical period is strongly connected to the notion of nature versus nurture in development. The concept of nature versus nurture does not concern only the development of language, but rather the development of various skills and behavioural patterns, with nature signifying the genetic (=inherited) influences, as opposed to nurture which signifies the learnt (=acquired) external influences. The debate essentially centres around a major question: To which extent are certain skills and behavioural patterns biologically pre-programmed, and to which extent are they influenced by external factors we are subjected to after birth? Lenneberg (1967), a pioneer in the field, argues that the critical period is a time when it becomes crucial for a certain development to occur, otherwise the ability will not be acquired at all, due to the rewiring of neural circuits in the brain. There is considerable evidence that language must be acquired before puberty for it to fully develop. There have been cases of children deprived of language learning up until late childhood who did not manage to develop full language skills, which suggests that a critical period for language acquisition exists. The most famous case was reported by Curtiss (1974). Curtis reported a study about a feral child called Genie. The child spent the first 13 years of her life in complete isolation, and thus was unable to acquire language in her early childhood. After her inclusion into society, she was able to develop nonverbal communication and certain social skills, however, she never fully developed sufficient language skills. Her case is therefore regarded as potential evidence of the existence of a critical period for language acquisition. Critical period is not an unfamiliar concept in the natural world. It has been studied across different domains and various animal species. Sources of evidence include, among others, for example a critical period in behavioural development of mammals (Wiedenmayer, 2010).

Depending on the linguistic domain, and on whether we are considering the speaker's L1 or L2, some authors prefer to use the term sensitive period, rather than critical, implying that the ability to acquire language only narrows, not fully closes (Guasti, 2016). The term sensitive period refers to a time window in which it is optimal to begin the acquisition of certain skills due to the development of brain regions and pathways (as opposed to critical period, which implies the impossibility of acquiring said skills after a certain time period).

Sensitive or critical periods are relevant to the standard linguistic development of a child. The stages and temporal key points of language acquisition in non-pathological conditions relevant to this study will be further discussed in the following chapter with regards specifically to phonological acquisition, the focus of the present study.

2. PHONOLOGICAL DEVELOPMENT

Due to the nature of the present study, the following chapter will discuss in greater detail the processes of phonological acquisition in infants and young children. This section also introduces one of the tasks commonly employed to evaluate phonological competence, which will later be analysed in the present study.

2.1. ACQUISITION OF PHONOLOGY

Acquisition of phonology begins already in infants. One of the most striking questions researchers attempt to answer is how an infant manages to develop a phonemic inventory (Ambridge & Lieven, 2011).

Infants begin their development as universal learners with the potential to form any phonemic inventory, and with the ability to discriminate all sounds (it is worth mentioning, however that this ability does not relate exclusively to speech sounds, but rather to sounds of any nature). What follows can be called a selective process by which infants narrow their perceptual sensitivities, enabling them to focus purely on the phonological system of their target language (Guasti, 2016).

Evidence has shown that children are sensitive to language even pre-natally and many studies have been carried out on infants as early as a few days after birth. Using a method known as high amplitude sucking procedure (Ambridge & Lieven, 2011), the infants suck on a non-nutritive treat while being presented with various stimuli. This procedure relies on the fact that infants are known to suck more intensely when they find the stimuli in their environment interesting. Thus, the sucking rate is measured to determine the infants' interest in the presented stimulus. This interest can be used to investigate the infants' ability to perceive a contrast between languages. The sucking rate increases when the infant is presented with a stimulus they find interesting. When they are subjected to a continuous unchanging stimulus, they become bored, and their sucking rate decreases. Therefore, when the sucking rate increases after the infants have been presented with a new stimulus, we can conclude that they have successfully recognized the change. In one of the pioneering studies in the field of phonological acquisition, Mehler (1988) presents evidence of four-day-old to 2-month-old infants "distinguishing utterances in their native language from those of another language" (Mehler, 1988, p. 35) in a crosslinguistic experiment including French and American children. The infants were able to discriminate languages when being presented with artificial stimuli, where the only information available was the sequencing of vowels and consonants – that is they were presented with artificially edited utterances which were stripped of intonation. The study therefore suggests that infants use temporal organization, rather than intonation, when perceiving differences between languages. As a reasoning for this ability, Mehler (1996) proposes the Rhythm Based

Language Discrimination Hypothesis – infants discriminate the languages due to their temporal organization that is based on sequences of vowels and consonants.

As infants develop, they begin to show increasing preference and sensitivity to the phonotactic features of their native language. This sensitivity manifests firstly around six months of age (Ambridge & Lieven, 2011). Evidence has shown that at twelve months of age infants have grown to mirror the adult perception of phonological contrasts, losing the ability to discriminate between phonemic contrasts of non-familiar languages, improving instead their sensitivity to differences that are valid in the context of their L1. Due to this development, after twelve months of age, children are no longer able to discriminate sounds that are not contrastive in their L1, a notable example being adult Japanese speakers not recognizing /l/ and /r/ as separate phonemes (Goto, 1971). The discrimination of /l/ and /r/ by Japanese speakers offers a valuable insight into the narrowing of perceptual sensitivity of infants towards phonemes irrelevant in their native language. The findings of a study by Tsushima (1994) confirmed that Japanese infants of 6-8 months were able to discriminate between /l/ and /r/, while infants aged 10-12 were not.

While perception is crucial for children's understanding of language, they must also acquire skills relevant to language production. Guasti (2016) places the first appearance of speech production at around 6 months of age, even though we can already perceive certain precursors of speech even earlier (such as cries and isolated vowel-like sounds). Production of a language begins at 6-8 months of age, with a practice phase of *"babbling",* when children affirm the correctness of their phonemic inventory through building sensory-motor representations and connecting them with the auditory input they perceive. Children first begin to produce babbling sounds displaying universal features which are not language specific. At around 8-10 months of age, their babbling starts to somewhat mirror their native language, in terms of features such as vowel quality (Boysson-Bardies, 1989). The babbling phase continues for several more months. While still in the babbling phase, infants already begin to produce the first meaningful words in their native language at around 10-12 months of age (Guasti, 2016).

2.2. Nonword Repetition tasks as means of assessing phonological development

Nonword repetition tasks have become one of the key instruments in tracking phonological development in children. They can also provide a valuable insight into whether there is a pathology in the phonological development of a child. Low scores in nonword repetition tests can have a variety of implications. As reported by Gathercole (1994), poor scores in nonword repetition tasks have consistently been found in children with low reading abilities, children with more general developmental language problems, and in neuropsychological patients with acquired disorders of language processing. Correlations were found between poor nonword repetition performance and impaired phonological short-term memory (Gathercole, 1994). Nonword repetition is a logical assessment strategy of phonological development, as it mimics processes all hearing children perform on their own (i.e. when they hear, repeat, and learn new words throughout their life). Nonword repetition tests therefore "provide a convenient laboratory analogue of imitation in natural language situations" (Gathercole et al., 1994, p. 2). The various processes involved in successful performance of nonword repetition will be further discussed in the following section.

2.2.1. Phonology and cognitive abilities involved in nonword repetition

Several factors may affect performance of children in nonword repetition tasks. Firstly, performance in a nonword repetition task may be affected by skills in phonological perception and analysis – children may have problems with perceiving sounds, or they might fail in repeating a nonword due to difficulties with segmentation of the given input (Snowling, 1991). Children with low scores in nonword repetition have been suggested to display problems in segmentation of the nonword into its phonological constituents or in representing the phonemes in their constitutive features (Gathercole et al., 1994). Since it is virtually impossible to design a phonological processing task which only requires phonological segmentation processes and no phonological representations, it is difficult to separate these two aspects in the assessment. Secondly, nonword repetition performance relies largely on working memory, due to its requirement of "temporary storage of an unfamiliar phonological sequence" (Gathercole et al., 1994, p. 19). According to Baddeley (1992), the working memory model functions through a phonological loop – a system for maintaining phonological information. The phonological loop is described as having two components, “a phonological store that can hold acoustic or speech-based information for 1 or 2 seconds” and “an articulatory control process, somewhat analogous to inner speech” (Baddeley, 1992, p. 3). The phonological loop can therefore store phonological information it has received, or it can take material that was presented visually (such as a written word or a picture) and register it into the phonological store (Baddeley, 1992). Nonword repetition tasks rely heavily on the function of the phonological loop. The nonwords are held for a short period of time within the phonological store and they achieve representation within the store (Gathercole et al., 1994).

Another process involved in nonword repetition which may influence the individual performance of a child is long-term knowledge of vocabulary. Gathercole’s (1994) analysis of nonword repetition results has shown that a nonword is more likely to be imitated correctly when it resembles a sound structure of familiar words. Therefore, the processes at play during nonword repetition are most likely to be, at least in some cases, a combination of long-term memory with the short-term phonological loop. Rispens (2012) examined the contribution of short-term working memory and phonological representations in NWR tasks, using nonword repetition, digit span, and word and nonword discrimination. In her study, NWR performance was strongly predicted by word and nonword discrimination, as well as digit span. Rispens (2012) thus concludes that both phonological short-term memory, as well as phonological representations contribute to performance in NWR tasks.

Finally, another important influence on the performance of children in nonword repetition may be a deficit in speech motor programming, which may influence the child’s final output. Thus, when possible, the aspect of output production should also be taken into account, especially in children under four years of age, who may display a large variation in articulatory output skills. (Gathercole et al., 1994).

2.2.2. The Children’s Test of Nonword Repetition

Developed by Gathercole, Willis and Baddeley, The Children’s Test of Nonword Repetition (CNRep) is a task designed specifically for English speaking child participants to evaluate their phonological skills. In their publication, the researchers present normative data of children aged four to nine years. The task involves children hearing and immediately repeating an unfamiliar phonological item. The aim of the task is to accurately reproduce 40 nonwords which have been carefully selected and categorized based on their length (ten in each category, the categories contain words of two, three, four, and five syllables). The highest score that can be obtained is 40 points – that is one point for each correctly reproduced nonword. The test does not score the reproduction of individual phonemes, only full nonwords – a child would not obtain partial points if part of the nonword was repeated accurately. The nonwords have all been designed to be phonotactically and prosodically legal, containing only phoneme sequences and stress patterns that are allowed in English. This was done as to minimise articulatory output demands (Gathercole et al., 1994). Results reported by Gathercole et al. (1994) clearly distinguish performance of language-impaired children from that of their age-matched, as well as reading level-matched control groups. Results from children with a language impairment were compared with data acquired from typically developing children in a larger longitudinal study (Gathercole, 1992). The performance of the eight-year-old impaired group corresponded with the performance of typically developing four-year-old children.

The CNRep task is commonly used in the United Kingdom to examine various aspects of phonological development. Some of the studies done using the CNRep include an experiment carried out by Bishop et al. (1996), in which the researchers examined twins with a language impairment either having or not having undergone speech therapy (it is worth noting that a study of this kind is rare in language acquisition research, as it offers a controlled environment). The study has shown that CNRep results can provide "a marker of the phenotype of heritable forms of developmental language impairment" (Bishop et al., 1996, p. 1). CNRep studies relevant to bilingualisms and DLD will be further discussed in the following sections of the theoretical background (sections 3.4; 4.2; 5.1).

It should be noted that several limitations of the CNRep have been discussed. One of the limitations proposed by Cilibrasi (2015) mentions the unequal distribution of noninitial clusters across the stimuli of varying lengths (noninitial clusters occur more in longer words, which might make length not the sole factor for a generally poorer accuracy in those words). Gray (2003) examined diagnostic accuracy and test-retest reliability of the CNRep in her study on children with a language impairment and she suggests that for certain uses of the test, a phoneme-by-phoneme accuracy, rather than a full word accuracy, might prove to be more effective. Additionally, it is crucial to mention that the task itself involves a variety of processes

(Gathercole, 1994; Rispens, 2012; Summers, 2009; Core, 2017), therefore poor performance might not carry clear cut implications which factors have caused the low score.

3. BILINGUALISM

The following section will discuss the phenomenon of bilingual acquisition. It will attempt to provide an explanation of what is currently understood under the label 'bilingualism' and what are the approaches towards bilingual division and classification. It shall then attempt to describe the bilingual development, with an emphasis on the differences from monolingual development (not only in the domain of language, but also in various other domains of cognition). The chapter will conclude with a focus on bilingual acquisition of phonology and a recount of previous cases of NWR administration in assessing language skills of bilingual speakers.

3.1. DEFINING BILINGUALISM

Providing a clear-cut definition of bilingualism is virtually impossible, since bilinguals are an extremely heterogenous group. Bilingual speakers come from a variety of different environments and the degrees of their proficiency in both of the languages can vary greatly. Furthermore, our understanding of the label has undergone a massive shift since researchers have first attempted to define bilingualism. What used to be perceived as a narrower category is now expanding and growing in complexity. A classic view describes bilingualism as native-like control of two languages (Bloomfield, 1933). This notion is nowadays widely discredited. Some say it offers "little help and is intrinsically arbitrary and ambiguous" (Baker, 2011, p. 15). Contrastingly, a much later definition provided by Grosjean (1989) asserts that a bilingual speaker is someone who is able to sufficiently function in each of their respective languages. That is still, however, a very vague definition for a clear classification of bilingualism. Bialystok (2001), a leading figure in bilingualism research, acknowledges that we cannot define bilingualism like any other usual variable used in research (e.g. age, gender), but describes it rather as "a scale, moving from virtually no awareness that other languages exist to complete fluency in two languages" (Bialystok, 2001, p. 8). As hard as it may be to define the borders of bilingualism, the phenomenon needs to be considered when studying language acquisition of children, as there is no doubt of the fact that the brain of children who are exposed to more than one language from an early age develops differently that the brain of their strictly monolingual peers. For any research to be done on the matter, there is, thus, a need to categorize the children that fall somewhere on the bilingual scale. This categorization shall be discussed in section 3.2.

With that being said, scholars agree that the extent of bilingualism is by no means insignificant as it can be found in all age groups, in all levels of society, and in most countries (Grosjean, 2013). Even though there is no clear data mapping the situation in the entire world, the estimate is that more than half of the world's population could be classified as bilingual. A 2006 report issued by the European Commission has shown that around 56% of people from 25 European countries are able to function in two languages (Grosjean, 2013). Looking at the rest of the world outside Europe, we can find many communities that use more than one language on a daily basis or countries housing numerous languages (some going as high as Nigeria, with over 500 languages, or India, with over 400).

3.2. Bilingual classification

Classifying bilingual speakers into categories is a difficult task. One could attempt a classification based on the speaker's fluency in the given languages and the individual language use. However, when considering the domain of child bilingual acquisition, the division is often based on a variable commonly called the age of onset. The age of onset as a means for bilingual categorization is used for various reasons. First reason being, it is a variable that allows to be measured quite easily (as opposed to the above-mentioned variable of language use). Age of onset proves to be not only a practical solution to the question of bilingual categorization, but also a logical one. As it was discussed in sections 1. and 2.1, the acquisition of language happens at a certain rate, with children acquiring different properties of language within a similar time frame. The acquisition of these properties is heavily linked to the development of a child's brain. When a child is exposed to a second language directly from birth, both of the child's languages will develop at a similar rate. However, when a child is exposed to a second language later, they are bound to acquire the features of said language at a different time frame. Here we should also consider the notion of sensitive period in language acquisition. If we recall the developmental milestones in phonetic acquisition mentioned in section 2.1, it will become evident why the initial age of exposure may play an important role in the child's ability to fully acquire both languages proficiently. A child might, for example, start acquiring a second language after their ability to perceive phonemic contrasts has already narrowed only to the sounds relevant in their mother tongue. Thus, this might make a difference in their acquisition of the phonemic inventory of said language, as opposed to children who have started acquiring the phonemes directly after birth. This phenomenon has been documented by Pallier (1997) in Spanish/Catalan adult speakers. Pallier (1997) tested two groups of adult bilingual speakers – one group of speakers exposed to Catalan directly after birth, one group of speakers exposed to Catalan slightly later, but still in early childhood. The group with the earlier age of onset was more successful in discriminating a contrast in vowels native to Catalan than the group with the later age of onset, even if both groups exhibited a native-like proficiency in the use of the language.

Researchers generally distinguish between simultaneous and sequential bilinguals, depending on how early the children are exposed to the second language. Due to the development of brain regions connected to language skills, which starts happening very shortly after birth, simultaneous and sequential bilingual acquisition is treated as a separate process by most scholars. Simultaneous bilingualism is mostly referred to as "a child acquiring two languages at the same time from birth" (Baker, 2011, p. 94), meaning that a child learns to understand the world through both of their languages at the same time. Sequential acquisition, on the other hand, means that the language is merely 'added' when a child already displays some (perhaps not fully developed) cognitive and linguistic abilities. Others go even further and present three distinct categories, such as Tsimpli (2014) and her division of bilingual acquisition into 'simultaneous', 'early successive', and 'late' categories.

3.3. BILINGUAL PROCESSING AND DEVELOPMENT

As has been previously acknowledged, a bilingual child's development differs from that of its monolingual peers. As Baker (2011) states, in the past, claims have been made that simultaneous acquisition "will muddle the child's mind and retard language development" (p. 94). It has, however, been proven by numerous studies that babies "appear biologically ready to acquire, store and differentiate two or more languages from birth" (Baker, 2011, p. 95). This section will provide a brief overview of the ways in which the development and processing of a bilingual child may differ from those of monolinguals. It is worth noting that most existing normative data regarding the assessment of linguistic development excludes bilingual speakers (i.e. most existing normative data regarding the assessment of linguistic development is that of monolingual speakers), as is the case with the CNRep task used in the present study. Bilinguals tend to be severely over- and under-represented in speech-language therapy (Marinis, 2017). Therefore, it is important to examine developmental differences between monolingual and bilingual children, as it may offer some understanding of performance of bilingual children in these standardized tasks, developed purely with monolinguals in mind.

As has been discussed in section 2.1, infants (whether bilingual or not) are able to discriminate between typologically different languages directly from birth. Within-rhythmic-class discrimination in bilingual children has been registered at 3,5 months of age (the case of Spanish & Basque; see Molnar, Gervain & Carreiras, 2014). These findings suggest that bilingual children are able to "track patterns in their two languages separately" (Guasti, 2016, p. 512) and therefore can create two separate language systems. Paradis (2001) investigated whether bilingual children actually possess two differentiated phonological systems. Paradis (2001) assessed two-year-old participants from a French-English background who all had French as the dominant language. The study included two control groups – English monolinguals and French monolinguals. Both monolingual and bilingual participants were tested with a nonword repetition task, and their performance was analysed for presence of patterns specific to French and English, as well as for similarities and dissimilarities between the experimental and control groups. The bilingual participants of this study showed evidence of sensitivity to language specific patterns. Therefore, Paradis claims that the bilingual participants have shown the ability to differentiate the two phonological systems of the languages. However, certain truncation patterns present in the performance of bilinguals differed from the performance of monolinguals. Bilinguals exhibited different truncation patterns in English sounding nonwords and therefore it appears that their phonological systems are not completely autonomous. The directionality of the influence in the study was from French to English (this finding was related to French being the dominant language of the participants), and the different truncation patterns appeared at points of interlanguage structural ambiguity (Paradis, 2001).

Elaborating on language discrimination, monolingual infants show the ability to recognize their native language from an unknown one purely on the basis of visual information (provided by 'silent talking faces'). However, they only do so up to 6 months of age. Bilingual infants, on the other hand, retain this ability. Weikum (2007) and other studies have shown that bilinguals are able to discriminate their native languages, as well as unknown languages they have not previously encountered purely on a visual basis at 8 months of age. Researchers have concluded that bilingualism "heightens infants' attentional ability to attend linguistically relevant cues" (Guasti, 2016, p. 513). Weikum (2007) assessed English monolingual and English/French bilingual infants at the age of 6 and 8 months on their ability to discriminate languages based purely on facial expressions, without any auditory input. The children were shown a silent video of an adult English-French bilingual speaker, uttering sentences in two languages. A control condition was carried out, with the speaker uttering two different sentences both in the same language. The video was shown until the looking time of the child declined past a certain limit. The test and control condition looking time was examined. The increase in looking time in the test condition indicated the infants' ability to perceive a language change. The results of the study show that while monolingual infants aged 8 months lost the ability to perceive a contrast in the two languages purely from visual information, bilingual infants aged 8 moths were able to retain this ability.

Bilingualism has been proven to carry certain disadvantages. Amongst the difficulties a bilingual child can face when learning and processing the two languages, we need to mention the fact that they tend to develop vocabulary and grammar more slowly than their monolingual peers. There may be a slight delay in certain language skills such as inflectional morphology or complex syntax, and their lexicon in each respective language can be smaller, at least in the first few years (Bialystok, 2001). Bilinguals may also face certain difficulties with lexical retrieval, meaning it can take more time for them to remember and utter a word, due to the activation of word-stock in both languages at the same time. Hence, they tend to exhibit poorer performance in a number of tasks assessing the lexicon (Bialystok, 2008). Another area which may cause problems in bilingual acquisition, is the interference between the two languages the child is learning, in other words, certain structures belonging to one language can manifest in the child's production of the other language. This phenomenon has been explored mainly in the field of acquisition of grammar (Sorace & Serratrice, 2009; Möhring, 2003), however, we can find this influence even in the field of phonology, as touched upon by Paradis (2001), mentioned above in this section. The interference of languages in bilingual acquisition is a vast topic, which will not be further developed in this introduction, as it is not the primary focus of the analysis.

Nevertheless, there are many advantageous ‘side effects’ of bilingualism, not limited merely to the linguistic skills of the child. Since language skills and cognition are closely interconnected and a bilingual child learns to understand the world through more than one language, there are consequences manifesting in the child’s cognitive abilities. In a pioneering study in the field of bilingual cognitive assessment, Peal & Lambert (1962) carried out a series of verbal and nonverbal intelligence tests, in which they expected the assessed bilingual children to perform more poorly than the assessed monolingual participants. However, bilingual participants showed better results in both tests, as opposed to their monolingual control group. Since then, researchers have investigated the bilingual effects in various domains related and unrelated to language. A very consistent finding in the field of bilingual cognitive processing is a working memory advantage, as reported in Bialystok (2004). Bialystok (2004) tested the executive functions of bilingual and monolingual children using the Simon task, where participants respond to visual stimuli by making either a leftward or a rightward response, depending on the stimulus type. The location in which the stimuli are presented to the child on a screen alternates (i.e. the stimulus can be presented in the upper right corner, in the bottom left corner, etc). Evidence from Bialystok shows that bilingual participants respond faster in conditions which place a greater demand on working memory. This effect was also found in middle-aged bilinguals, showing that bilingualism helps enhance executive functions even in older speakers (Bialystok, 2004). Recent works imply that the bilingual advantage may not only affect executive functions of the speakers, but also their social skills. A study by Liberman (2016) investigated the effect of bilingualism on communication and social skills in infants. Children aged 16 months were tested in a communication task, which required an understanding of the perspective of a speaker. The speaker presented the infants with two identical toys (e.g. two cars), one of which was mutually visible to both the child and the speaker. The second toy was blocked from the speaker’s view. The speaker then asked to be handed a toy. Monolingual children chose randomly between the two toys, whereas infants with multilingual exposure tended to choose the toy mutually visible by both parties, which suggests that they are more successful in imagining the speaker’s perspective.

3.4. NWR IN BILINGUALS

Most of the normative data available for NWR performance is that of monolingual speakers. However, in recent years, scholars have started paying more attention to bilingual performance in various linguistic tasks, NWR included. This section will introduce several studies examining nonword repetition performance of bilingual children. It is worth noting that the majority of studies in said field are centred around Spanish/English bilinguals, as this combination of languages is very common in the US.

Thorn and Gathercole (1999) examined the performance of monolingual and bilingual children in a nonword repetition task, using both English sounding and French sounding stimuli. They assessed three groups of participants – monolingual English children, simultaneous English/French bilingual children, and English children who were learning French as their L2. Both French speaking groups – simultaneous bilinguals as well as children learning French as their L2 – exhibited a similar performance in a vocabulary assessment and in a NWR assessment. Thorn and Gathercole (1999) therefore interpreted the results as there being a link between phonological performance and vocabulary knowledge in bilinguals. Summers et al. (2009) aimed to examine NRW performance of Spanish/English bilinguals (L1 Spanish, L2 English) in both languages. The participants (between ages of 4 to 6 years) were presented with both Spanish-like and English-like nonwords, and completed follow up semantic and morphosyntactic tasks, with the aim to explore the interaction between NWR performance and language experience. The children's performance was more accurate in Spanish-like nonwords. Performance in English-like nonwords correlated with exposure and age of onset, which suggests that earlier exposure and bigger amount of exposure to a given language can modulate NWR performance. A similar study by Core et al. (2017) examined the role of language experience on NWR performance, using English-like as well as Spanish-like items to test Spanish/English bilinguals (simultaneous bilinguals with more exposure to English than Spanish). The study compared 30-month-old participants to their age matched monolingual English peers, taking into account the amount of exposure to each language the bilingual participants had. Contrary to Core's expectations, the two groups did not differ significantly in the accuracy of production in the English-like NWR task. Core et al. (2017) also compared the bilinguals' production of English-like and Spanish-like items, however, unlike the previously mentioned study by Summers, differences were not found between the accuracy in the two languages. Core (2017) therefore suggests that the findings support clinical use of NWR tasks as a measure of phonological memory in simultaneous bilinguals. A study by Lee et al. (2012) examined NWR performance and its related factors across four distinct linguistic groups in 7-year-old participants – monolingual English speakers, Korean/English speakers, Chinese/English speakers, and Spanish/English speakers. The main aim of the study was to analyse potential influence of varying linguistic backgrounds on NWR performance. The study therefore compared NWR of English-like items and found no significant effect of group on overall performance, contrasting previous studies concerning a similar matter (Paradis, 2001; Summers, 2009). Lee (2012) attributes this result to the higher English proficiency of their bilingual participants. What they did find, however, were significant differences in consonant and vowel accuracy. Lee (2012) therefore suggests that while bilinguals may not necessarily display lower performance scores, they may display different patterns influenced by the phonemic inventory of their dominant language. This notion will be mentioned in following chapters, given that it serves as a a rationale of the current study.

4. DEVELOPMENTAL LANGUAGE DISORDER

Developmental language disorder or DLD – previously referred to as SLI (=Specific Language Impairment), a term which has been abandoned, due to its restrictive nature (Bishop, 2016) – describes a condition "in which there is a mismatch between the language system and other cognitive capacities and there is no obvious cause for the language disorders" (Guasti, 2016, p. 468). In other words, children with this disorder show impairment in language skills but no impairment in other areas of cognition. Despite being described as a pathological language skills condition, DLD can co-occur with a weakness in working memory, poor motor skills, developmental dyslexia, and sometimes even ADHD. The complete causes of DLD are unknown. It has been suggested, however, that it could operate on a genetic basis. Several studies have observed a familial aggregation – it is more likely to find the disorder in families, where it has appeared before. Additionally, Bishop (1995) examined pairs of monozygotic and dizygotic twins of which at least one of them showed signs of DLD and according to the study, the data showed "a strong evidence of heritability" (p. 12).

DLD is a very broad term that encompasses a variety of different language problems – it is therefore important to classify DLD into several categories. There are, nevertheless, several common markers found across DLD children. Among the common characteristics of DLD are a later emergence of language, language skills below age expectations, and problems with inflectional morphology (Guasti, 2016). Among the varying difficulties an individual child with DLD may or may not exhibit are problems with other areas of grammatical knowledge, phonological deficits, problems with lexical acquisition and retrieval, and/or correctly interpreting language embedded in a situation. The deficit may also vary in being either receptive, expressive, or both (Guasti, 2016). After assessing children diagnosed with DLD with a battery of tests focused on separate language domains, Friedmann and Novogrodsky (2008) have divided the condition into distinct subtypes: Syntactic, Phonological, Lexical and Pragmatic. Each of these groups shows different clinical markers for the disorder. The deficits may overlap, that is one child may display markers of more groups, but it can also happen that a child displays for example phonological processing difficulties, but their syntax remains unimpaired.

4.1. Phonological deficit in DLD children

The following section will focus in more detail on the characteristics of the phonological subtype of DLD, due to its relevance for this study. Children with this type of DLD generally display difficulties with phonological processing – namely difficulties with storing phonological information in short term memory, retrieving phonological information from long term memory, and awareness of the individual sounds in a spoken structure of words (Wagner & Torgesen, 1987). To assess whether the tested children showed a deficit in the domain of phonology, Friedmann and Novogrodsky (2011) presented them with a series of tasks. All the children classified as PhoSLI (= phonological subtype of DLD) exhibited poor performance in a test of repetition of complex words and nonwords (containing complexities such as initial and medial clusters or feature similarities), a judgment test of nonwords (some of the presented stimuli were in line with phonological rules, some violated them), a phonemic awareness task (representing sound sequences with colourful blocks + determining whether a presented pair of words starts with the same sound), and a working memory subtest. Among these, NWR tasks are most commonly taken as a clinical marker of phonological DLD, and therefore used as a tool for its assessment.

4.2. NWR ASSESSMENT OF DLD CHILDREN

Since researchers mostly agree that the problem in children with a phonological subtype of DLD lies in their limited capacity of phonological processing (i.e. in their inability to form and hold accurate phonological representations in their working memory), nonword repetition, which functions as a test of phonological working memory, proves to be an extremely useful assessment tool (Gathercole, 1994). Additionally, it has been proven useful as a testing measure for various types of DLD, not merely a strict phonological one. Botting (2001) carried out a study comparing language abilities of groups of typically developing and impaired children with similar NWR performances on the basis of various other linguistic assessment criteria. Results of the experiment, as reported in Botting (2001), clearly indicate a relationship between performance on a nonword repetition task and actual language ability. Nonverbal performance and IQ of the participants was also measured, proving a dissociation between general cognitive skills and the children's language skills. Botting (2001) also remarks on his finding of DLD diagnosed children who scored highly on the NWR task but concludes that since they are a very small subgroup (6%), these children fall outside the typical range of impairments seen in DLD.

NWR testing in DLD children has been consistently used in both clinical and research settings across different languages (see Archibald 2008 for elaboration on NWR in clinical settings). Among studies carried out in research settings, we can mention for example Loucas (2016) who used a nonword repetition task to assess different levels of phonological processing in children with DLD, or Sundström (2018) who tested the phonological production of Swedish children with DLD using a Swedish modelled nonword repetition task. Loucas (2016) used a battery of tests, including a NWR task to assess the phonological awareness of children with and without DLD (exhibiting problems with phonology and reading). The group that exhibited both reading and phonology problems, as well as the group that only exhibited reading problems scored lower than the groups of TD children and children only exhibiting phonological problems in the NWR task. Sundström (2018) compared the NWR performance of DLD children with the performance of children with a hearing impairment and found that their NWR scores did not differ significantly. Both the DLD and the hearing-impaired group's scores were, however, lower that the scores of a TD control group. It is important to note that NWR performance accuracy may not be related merely to working memory. Cilibrasi et al. (2018) examined the relationship of working memory and phonological complexity in the performance accuracy of DLD children. The study showed that DLD children (as well as a typically developing control group) had significantly poorer performance in nonwords which contained more phonologically complex items.

5. BILINGUAL OR DLD?

A problem arises when we consider the relationship between DLD and bilingual language acquisition. Especially if we consider bilinguals belonging to the category of 'early successive' or 'late' acquisition (section 3.2), evidence shows that they might develop certain language skills later and might be therefore lagging behind their age matched peers if assessed by standardised measures created for monolingual children. Since their development of lexicon, inflectional morphology, complex syntactic structures, or phonology might happen at a slower rate and since they might be influenced by an interference from another language, they are naturally bound to display below norm results in tests developed with a purely monolingual acquisition in mind. We are therefore facing a problem of misdiagnosing bilingual children as having DLD (Guasti, 2016). Grosjean (2013) also mentions the outdated view sometimes expressed by speech therapists and teachers claiming that in order to prevent any more pathological conditions in children who are both bilingual and diagnosed with DLD, one of the languages should be withheld from the child in order to reduce the burden. That claim is, however, not supported by research, since bilingualism "does not exacerbate any of the problems posed by speech disorders" (Grosjean, 2013, p. 139). Grosjean (2013) suggests that bilingual acquisition might even prove advantageous to a child displaying signs of DLD, as bilingualism has been proven to offer cognitive advantages, as was discussed thoroughly in sections 3.2. and 3.3. with reference to several studies (Pearl & Lambert, 1962; Bialystok, 2004; Liberman, 2016). The relationship between DLD and bilingualism will remain problematic as long as monolingual norms are used when assessing bilingual children.

To reach a conclusion in the matter of disentangling bilingualism and DLD, it is important to closely examine the linguistic profiles of DLD children and bilingual children, and to see how their performance might differ in the types of tasks traditionally used to assess a developmental language disorder, in order to separate typically developing bilingual children from those who actually do suffer from this condition. Disentangling bilingualism and DLD is an extremely difficult task, since both of these groups are hard to define by themselves. In bilingual children, one has to consider the age of onset of the language, the amount of exposure to the language they have been presented with, and other variables such as where they encounter said language (one parent speaking the language / both parents speaking the language / a child only encountering the language at school, etc). On the other end of the problem lies the heterogenous nature of DLD with the different domains affected and the varying degrees of the impairment (Armon-Lotem, 2011).

Researchers have recently started investigating the options for diagnosing DLD in bilingual children. Marinis (2011), Chondrogianni (2012), as well as other scholars have examined the relationship of DLD and bilingualism on the basis of the children's morphosyntax, mainly their production of tense morphemes. Results of these studies have led to a somewhat possible measure of differentiating typically developing bilinguals from bilinguals with a developmental language disorder on the basis of the Test of Early Grammatical Impairment, which would place more focus on morphological markers of DLD. Several other measures have been proposed as possible markers of DLD in bilingual children. Jacobson (2012) reports the possible use of object clitics in L1 as a possible marker of BIDLD. In her study, bilingual children with DLD exhibited problems with object clitics even in later grades, as opposed to TD bilingual children. Following works by Rothweiler (2012), Chilla and Barbour (2010), Armon-Lotem (2012) suggests that agreement and case errors could serve as a possible marker of BIDLD. The aforementioned suggestions for bilingual DLD testing are relevant when assessing bilinguals with a late age of onset, and when looking for markers of syntactic DLD. If we want to assess simultaneous and early sequential bilinguals, and if we're looking rather for signs of phonological DLD, examining the phonological abilities of a child would prove more useful.

5.1. NWR CROSS-ASSESSMENT OF BILINGUALS AND DLD

The following section will present several studies analysing the relationship between DLD and bilingual performance in NWR tasks. A number of studies have attempted to disentangle the markers of DLD and bilingualism in NWR tasks. Thordardottir (2013) attempted a nonword repetition and a sentence imitation assessment of French/English bilingual children and DLD children, in order to observe any possible varying patterns in their performance (with regards to the effect of varying degrees of bilingual exposure). For nonword repetition assessment in English, the CNRep task was used, therefore the stimuli present were of varying lengths. The results of the CNRep testing firstly show that bilingual children with low scores were the ones with the least amount of exposure to English. Contrastingly, conclusions made from the results of high scoring participants reveal that with the "critical exposure level of approximately 35–40% of waking hours since birth, 5-year-old children can be expected to perform similarly to native speakers on this particular English nonword repetition test" (Thordardottir, 2013, p. 8). With regards to the difference in the performance of typically developing bilingual vs. typically developing monolingual vs. language impaired monolingual children, the results of the study indicate that "nonword length does not tax the abilities of bilingual children in the way that taxes the abilities of children with PLI (=phonological language impairment)" (Thordardottir, 2013, p. 8), as the bilingual participants were not affected by length any more than monolingual typically developing participants. Windsor et al. (2010) took on a similar task of examining the utility of English and Spanish nonword repetition tests to identify children with a language impairment amongst English/Spanish bilinguals. Participants of the study included typically developing bilingual and monolingual groups, as well as bilingual and monolingual groups with a language impairment. It is necessary to note here that the diagnosis of bilingual participants as having DLD was done using monolingual norms, therefore it should be taken critically. Windsor (2010) reports that both of the bilingual groups (TD and DLD) showed a higher performance in the Spanish NWR task than in the English one. In the English task, TD bilinguals outperformed DLD bilinguals in repeating words containing more syllables. However, when comparing typically developing bilinguals and monolinguals with DLD, Windsor (2010) reports that when it comes to overall accuracy scores, "the typical bilingual children performed similarly to the monolingual English children with LI (=language impairment) in English NWR (p. 9). The study thus concludes that only after administrating both the English and Spanish tasks, one would be able to sufficiently diagnose bilingual children as having a language disorder, since poor performance in one language might not equate DLD, but rather a number of effects connected to bilingualism, exposure to the language of the NWR task, etc. "Overall, the current study supports an increasing body of literature demonstrating that NWR in a single language is not sufficient to act as a clinical marker of LI in linguistically diverse populations." (Windsor, 2010, p. 10). In a similar study Gutiérrez-Clellen (2010) examined the degree to which individual differences in language skills and use influence the clinical differentiation of Spanish/English bilingual children. Both TD and DLD participants were tested in NWR tasks using lists of nonwords developed for both of the languages. As in Windsor (2010), the results showed that clinical accuracy of NWR tasks varied depending on the language in which NWR was tested. Due to the striking difference between both of the tested languages, Gutiérrez-Clellen (2010) states that her findings "do not support a monolingual approach to the assessment of bilingual children with nonword repetition tasks, even if children appear fluent speakers in the language of testing" (p. 1) and suggests that NWR tasks should be used bilingually and combined with other clinical measures, such as the use of past tense verb markings, in order to obtain a more accurate picture of the child's language abilities.

As evidenced by previously mentioned studies, both DLD and bilingual children may, for various reasons, display phonological deficits and perform below average on nonword repetition tasks. This study aims to analyse the performance of monolingual DLD and typically developing bilingual children with varying ages of onset in a NWR task, to see whether the patterns in their performance might differ (as opposed to the overall accuracy in the task, which is commonly taken as a basis for assessment). The possible difference in patterns in a NWR performance could shed more light on the question of markers of DLD vs bilingualism. The study will examine 3 groups of participants – monolingual English speakers diagnosed with DLD, typically developing simultaneous bilingual speakers of Czech-English, and typically developing sequential bilingual speakers of Czech-English.

METHODS

The following chapter will describe in detail the research procedures used to complete the present study. The chapter will elaborate on experimental groups, tests used to obtain the data, as well as the analyses which have been run.

1. EXPERIMENTAL GROUPS

In the present study, the performance of 3 groups of children was examined.

The first group examined in this study consisted of 18 participants, all monolingual speakers of English, who have been evaluated at the Speech and Language Therapy Clinic at Reading University, School of Psychology. All participants in this group were diagnosed with a developmental language disorder (DLD). None of the participants in the sample exhibited developmental difficulties unrelated to language (participants with hearing problems and participants that had suffered from a stroke prior to the assessment were excluded from the sample). The age range of the participants in this group was 5 to 14 years. The above-mentioned Speech and Language Therapy Clinic has kindly provided their data for the purposes of this study, as well as a written consent.

The second group examined in this study consisted of 11 participants, all bilingual speakers of English and Czech from bilingual backgrounds, acquiring both English and Czech directly from birth (= simultaneous bilinguals). The age range of the participants in this group was 9 to 11 years.

The third group consisted of 23 participants, all bilingual speakers of English and Czech, who started acquiring English from the ages of 1 to 4 (= early sequential bilinguals). The age range of the participants in this group was 9 to 11 years.

The data for both bilingual groups were collected by Alžběta Brabcová during a background test in a 2018 study run at the Department of English Language and ELT Methodology, Faculty of Arts, Charles University. None of the bilingual participants exhibited markers of language disorders, cognitive problems, or hearing problems. A questionnaire distributed to the parents of the participants specified their age of onset and made the division into two groups possible. A parental consent for the testing was also provided from each participant.

The bilingual children were divided into simultaneous and sequential groups, due to the nature of the present study, which focuses solely on phonological language acquisition. As discussed thoroughly in section 2.1., infants begin the selective hearing process of their target language very shortly after birth, and they already exhibit sensitivity towards features of their mother tongue around 6 months of age (Ambridge & Lieven, 2011). Therefore, given the specifics of phonological acquisition, the available data was divided into simultaneous and early sequential groups.

2. STIMULI

All analysed data was acquired using a nonword repetition test, namely The Children's Test of Nonword Repetition (CNRep) developed by Gathercole (1994). The CNRep is a highly used standardized nonword repetition test, designed specifically to assess the performance of young speakers of English. During the test, children are tasked with repeating a set of 40 nonwords of varying lengths (2 – 5 syllables, 10 in each condition), as a means of assessing their phonological working memory and overall phonological competence. The 40 nonwords present in the CNRep test only contain sound sequences and stress patterns which are phonologically and prosodically legal in English. The test items are presented to the participant in a randomized order, alternating between each of the syllable lengths of the nonwords. Below are listed examples of nonwords included in the CNRep task:

2 syllables: ballop, diller

3 syllables: glistering, barrazon

4 syllables: fenneriser, woogalamic

5 syllables: confrantually, versatrationist

Before the assessment itself begins, the child is first presented with two trial items. The highest obtainable score in a standard CNRep evaluation is 40 points, each correct response awarded with one point, not considering the length or phonological complexity of the given nonword. The test does not take into consideration partially correct responses – therefore it is not possible to obtain partial points. A point is awarded only in the condition that the entire nonword is reproduced accurately. The evaluation of the test is done based on the total number of points the participant has received.

Normative CNRep performance data of monolingual children aged 4 to 9 years – both typically developing and with a language impairment – from Gathercole (1994) is available. CNRep is often used as one of the tools for assessing language impairments, as impaired children tend to score lower than typically developing children (as evidenced by Gathercole, 1994).

For the purposes of this study, performance of the participants was not evaluated with regards to the CNRep point scoring system. Instead, categories of items were created, and the data was analysed with regards to certain aspects of the performance of each experimental group. These categories will allow for a closer examination of the subjects' performance, since the groups might not differ in overall accuracy scores, but they may differ in terms of patterns found in their performance. The following section will explain in more detail the categories of items created for this study.

Firstly, the testing items were divided into 4 categories based on the syllable length, each category comprised of 10 nonwords. (see section 3. Analysis; MODEL 1)

Additionally, the study focuses on the more problematic 4 and 5 syllable nonwords (Gathercole, 1994). Following previous work presented by Cilibrasi et al. (2018), the 4 and 5 syllable nonwords were further divided into two categories, based on the presence or absence of a noninitial cluster in the given nonword. Results of Cilibrasi et al. (2018) show that long nonwords containing a noninitial cluster are repeated less accurately in both typically developing and impaired children. The study also found that young children tend to make a similar number of errors in words with and without clusters, but older children tend to make more errors in words containing a cluster. The study therefore suggests that problems in certain long nonwords may not only be caused by a deficit in phonological memory, but also by the phonological complexity of the nonword. The present study will analyse the performance in long nonwords with and without cluster in typically developing bilingual children of varying ages of onset, and in monolingual children with a language impairment.

Four categories were therefore created – 4 syllable nonwords with noninitial clusters, 4 syllable nonwords without noninitial clusters, 5 syllable nonwords with noninitial clusters, and 4 syllable nonwords without noninitial clusters. Each of these categories contains 5 of the test items from the original set of CNRep stimuli. Stimuli were divided into items with and without noninitial clusters, based on Roach's (2010) definition of a cluster. Roach links his definition of a cluster to the definition of a syllable, and to the principles for minimal and maximum onset and coda of a syllable. For the purposes of this study, a cluster is not defined as a mere sequence of two consonants regardless of their position, but rather as a sequence of two consonants which belong to one syllable. This choice was made due to the nature of the test used in the study, whose items mimic the natural pronunciation of the English language. Therefore, a cluster does not cross the boundary of the phonological unit, a syllable. Roach defines two groups of two-consonant clusters, which are allowed to be present at the onset of the English syllable (Fig 1). First category is composed of "s followed by one of a small set of consonants; examples of such clusters are found in words such as 'sting', 'sway', 'smoke'" (Roach, 2010, p. 57). The other set of consonant clusters allowed at the onset of a syllable "begins with one of a set of about fifteen consonants, followed by one of the set l, r, w, j as in, for example, 'play', 'try', 'quick', 'few' (Roach, 2010, p. 57).

Pre-initial s **followed by:**

INITIAL

p	t	k	b	d	g	f	θ	s	ʃ	h	v	ð	z	ʒ	m	n	ŋ
spɪn	stɪk	skɪn	–	–	–	sfɪə	–	–	–	–	–	–	–	–	smel	snəʊ	–

POST-INITIAL	p	t	k	b	d	g	f	θ	s	ʃ	h	v	ð	z	ʒ	m	n	ŋ	l	r	w	j
l	pleɪ	–	kleɪ	blæk	–	gluː	flaɪ	–	slɪp	–	–	–	–	–	–	–	–	–	–	–	–	–
r	preɪ	treɪ	kraɪ	brɪŋ	drɪp	grɪn	fraɪ	θrəʊ	?[1]	ʃruː	–	–	–	–	–	–	–	–	–	–	–	–
w	–	twɪn	kwɪk	–	dwel	?[2]	–	θwɔːt	swɪm	?[3]	–	–	–	–	–	–	–	–	–	–	–	–
j	pjɔː	tjuːn	kjuː	bjuːti	djuː	?[4]	fjuː	?[5]	sjuː	–	hjuːdʒ	vjuː	–	–	–	mjuːz	njuːz	–	ljuːd	–	–	–

Fig 1: Consonant clusters allowed at the onset of a syllable (Roach, 2010)

As for the two-consonant clusters allowed at the coda of a syllable, Roach again groups them in two categories. "There are two sorts of two-consonant final cluster, one being a final consonant preceded by a pre-final consonant and the other a final consonant followed by a post-final consonant. The pre-final consonants form a small set: m, n, r, l, s. We can see these in 'bump', 'bent', 'bank', 'belt', 'ask'. The post-final consonants also form a small set: s, z, t, d, θ; example words are: 'bets', 'beds', 'backed', 'bagged', 'eighth'" (Roach, 2010, p. 59).

For a group of sounds to be classified as a consonant cluster, it also needs to adhere to the maximal onset principle, stating that "where two syllables are to be divided, any consonants between them should be attached to the right-hand syllable, not the left, as far as possible" (Roach, 2010, p. 61). However, the principle can only be applied when when the division into syllables respects which sounds can accur at the end of a syllable, as certain vowels cannot take on the final position. “The maximal onsets principle must therefore also be modified to allow a consonant to be assigned to the left syllable if that prevents one of the vowels ɪ, e, æ, ʌ, ɒ, ʊ from occurring at the end of a syllable” (Roach, 2010, p. 61).

Phonotactic principles for syllabification and Roach’s definition of cluster served as a guideline for creating the following categories. Below are examples of nonwords included in each category (see section 3. Analysis; MODEL 2):

- 4 syllable nonwords with noninitial cluster: contramponist, empliforvent
- 4 syllable nonwords without noninitial cluster: comeecitate, fenneriser
- 5 syllalble nonwords with noninitial cluster: confrantually, detratapillic
- 5 syllable nonwords without noninitial cluster: altupatory, defermication

3. ANALYSIS

The data for each of the experimental groups (1. DLD, 2. simultaneous bilinguals, 3. sequential bilinguals) was analysed separately with a linear mixed effects regression model, using R (R Core Team, 2012) and lme4 (Bates et al., 2014).

Firstly, data relevant to the two created models was extracted from the available administered CNRep forms. For each of the chosen conditions, accuracy per participant in said condition was counted, varying on a scale from 0 to 1 (accuracy 0 if no items were reproduced correctly; accuracy 1 if all items were reproduced correctly). Age was centred around the mean for each group. A separate table of data per group was created for each experimental question. Below pictured are excerpts from the datasets created for the analysis.

Table 1: Excerpt from a dataset of DLD group's performance in relation to the length of the nonword (dataset for MODEL 1)

Participant	Accuracy	Length	Age
1	0,8	2	6,24
1	0,7	3	6,24
1	0	4	6,24
1	0	5	6,24
2	0,7	2	-29,76
2	0,1	3	-29,76
2	0,2	4	-29,76
2	0,2	5	-29,76
3	1	2	-8,76
3	0,8	3	-8,76
3	0,9	4	-8,76
3	0,6	5	-8,76

Table 2: Excerpt from a dataset of DLD group's performance in long nonwords in relation to the presence of noninitial clusters (dataset for MODEL 2)

Participant	Accuracy	Cluster	Length	Age
1	0	YES	4	6,24
1	0	NO	4	6,24
1	0	YES	5	6,24
1	0	NO	5	6,24
2	0	YES	4	-29,76
2	0,4	NO	4	-29,76
2	0	YES	5	-29,76
2	0,4	NO	5	-29,76
3	1	YES	4	-8,76
3	0,8	NO	4	-8,76
3	0,6	YES	5	-8,76
3	0,6	NO	5	-8,76

As previously mentioned, each group's datasets were analysed separately. This decision was taken due to the mismatch of the age range and the sample size of the DLD and bilingual groups. The normality of the data was checked using Shapiro-Wilk test (Shapiro & Wilk, 1965). The test found significant deviations from a normal distribution, therefore a linear mixed effects model (LME) was chosen, as opposed to a simple linear regression model. Schielzeth et al. (2020) state that mixed effects models can be employed even when distributional assumptions are violated, as LMEs are robust to these violations. Schielzeth (2010) reports that fixed effects in particular are relatively unbiased. In addition, a mixed effects model allows to take into consideration individual participant differences. Two linear mixed effects models were designed to examine how the groups behave in two selected conditions.

3.1. MODEL 1: ACCURACY BASED ON NUMBER OF SYLLABLES

The first research question of the study focused on the performance accuracy in different word lengths. A model was designed with accuracy as the dependent variable, and length of the nonword (all lengths from 2 to 5 syllables, see Model 1: Length1) and age of the participant as fixed effects. Random effect of participant was added to account for random variation due to individual differences. The linear mixed effects model allowed to examine the interaction of several fixed effects, while taking into consideration the random variation due to individual differences of each participant. Below is the R code for the finalised model.

MODEL 1: lmer (Accuracy ~ Length1 * Age + (1|part))

3.2. MODEL 2: ACCURACY BASED ON THE PRESENCE OF NONINITIAL CLUSTER IN LONGER NONWORDS

Similarly, the second research question examined the accuracy in four and five syllable nonwords with and without noninitial clusters, using a linear mixed effects model. As in the previous model, the accuracy was the dependent variable. However, in the second model one additional fixed effect was included – the presence or absence of cluster. Therefore, the model examined the interaction of length, cluster, and age. As opposed to the first model, the fixed effect of length only included two categories – nonwords of 4 and 5 syllables (see Model 2: Lenght2), as noninitial clusters are only present in the longer nonwords of the CNRep task. Random effect of participant was added to account for random variation due to individual differences. Below is the R code for the finalised model.

MODEL 2: `lmer ( Accuracy ~ Length2 * Cluster * Age + (1|part) )`

RESULTS

The following section will cover the results obtained by the previously introduced analyses. Results obtained by the two models for each experimental group are presented below.

1. DLD

Firstly, the results of monolingual speakers of English with a developmental language disorder (the DLD group) will be presented.

MODEL 1

A linear mixed effects model was carried out with length and age as fixed effects, and accuracy as the dependant variable. Descriptive statistics for said model are presented below in Table 3.

Table 3: Descriptive statistics for syllable length accuracy in DLD group

	2 syllables	3 syllables	4 syllables	5 syllables
Mean (SE)	0,8 (0,05)	0,6 (0,06)	0,5 (0,07)	0,4 (0,07)
SD	0,22	0,28	0,32	0,29

The model showed a significant main effect of age, $t(16)=2.83$, $p = 0.01$. Age had an overall positive effect on the performance, as seen in Fig 2 which depicts the proportion of accurate answers increasing with the increase of age of the respondents. An interaction between age and length in 4 and 5 syllable nonwords was found, $t(47)=2.69$, $p= 0.009$ (Fig 3). No other main effect or interaction reached significance in the analysis. An overview of the model output can be found below in Table 4.

Table 4: Summary of the linear mixed model effects for MODEL 1

	Estimate	**SE**	**dF**	**t value**	***p***
Intercept	0.66	0.07	16.00	9.09	< 0.001
Length1 2-3 syl	- 0.1218506	0.17	47.99	- 0.70	0.48
Length1 4-3 syl	- 0.13	0.17	47.99	- 0.80	0.42
Length1 5-4 syl	0.11	0.17	47.99	0.68	0.49
Age	0.006	0.002	16.00	2.83	0.01
Length1 3-2 syl : Age	0.003	0.005	47.99	0.73	0.46
Length1 4-3 syl : Age	- 0.0004	0.005	47.99	- 0.07	0.93
Length1 5-4 syl : Age	0.014	0.005	47.99	2.69	0.009

SE standard error, *dF* degrees of freedom, *Length1* 2,3,4,5 syllable nonwords

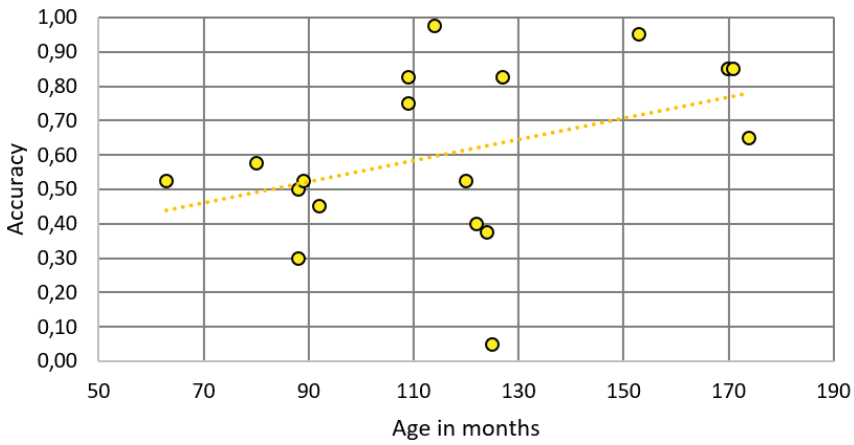

Fig 2: Proportion of correct answers across different ages in DLD children. This figure represents the main effect of age. Overall, as age increases, so does the proportion of correct answers. Accuracy was obtained dividing the number of correct responses by the number of items repeated.

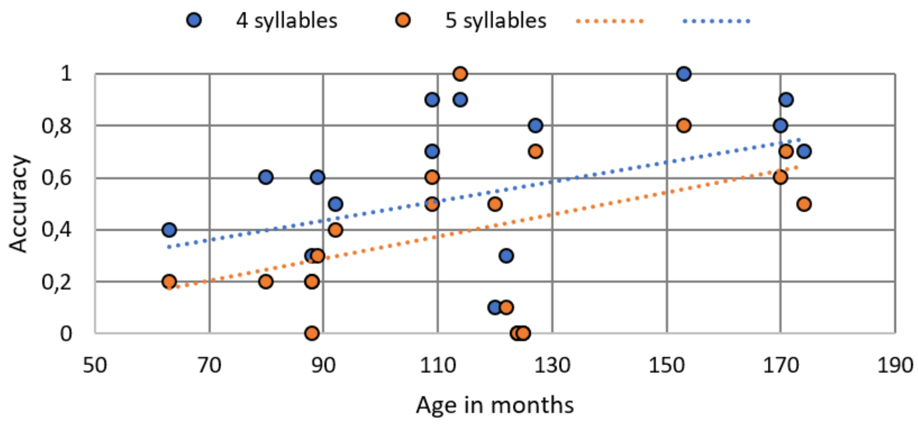

Fig 3: Proportion of correct answers in 4 and 5 syllable nonwords across different ages in DLD children. This figure represents the interaction between age and length in long nonwords. 4 syllable nonwords were repeated overall more accurately than 5 syllable nonwords, as shown by the position of the blue and orange lines. In both 4 and 5 syllable nonwords, the accuracy in performance increased with age, however the increase is higher for 5 syllable words.

MODEL 2

The second portion of the DLD group analysis focused on the participants' performance in long nonwords with the presence and absence of noninitial clusters. A linear mixed effects model was carried out with length (4 vs. 5 syllable nonwords), age and cluster as fixed effects, and accuracy as the dependant variable. The model showed a significant effect of length, $t(48)= -2.7$, $p = 0.009$ (Fig 4), and cluster $t(48)= -2.96$, $p = 0.004$ (Fig 5), and a marginal main effect of age, $t(16)=2.02$, $p = 0{,}059$. No other main effect or interaction reached significance in the analysis. An overview of the model output can be found below in Table 5.

Table 5: Summary of the linear mixed model effects for MODEL 2

	Estimate	**SE**	**dF**	**t value**	***p***
Intercept	0.47	0.06	16.00	7.35	< 0.001
Length2	- 0.11	0.04	48.00	- 2.70	0.009
Cluster	- 0.12	0.04	48.00	- 2.96	0.004
Age	0.004	0.002	16.00	2.02	0.05
Length2 : Cluster	- 0.12	0.08	48.00	- 1.42	0.1
Length2 : Age	0.001	0.001	48.00	1.04	0.3
Cluster : Age	0.001	0.001	48.00	1.22	0.2
Length2 : Cluster : Age	- 0.001	0.002	48.00	- 0.69	0.4

SE standard error, *dF* degrees of freedom, *Length2* 4,5 syllable nonwords

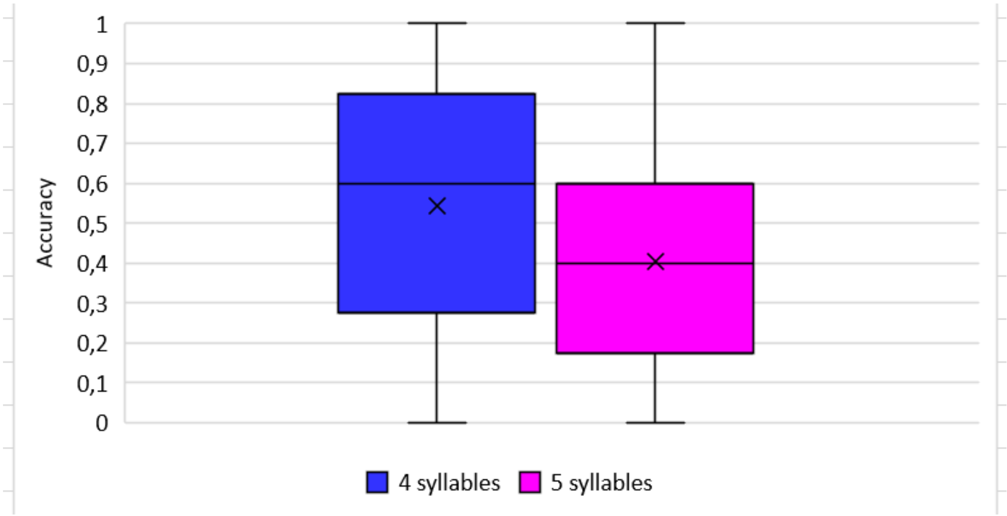

Fig 4: Proportion of correct answers in nonwords with 4 and 5 syllables in DLD children. This figure represents the main effect of length. Accuracy was obtained dividing the number of correct responses by the number of items repeated. Overall, nonwords with 4 syllables were repeated more accurately than nonwords with 5 syllables.

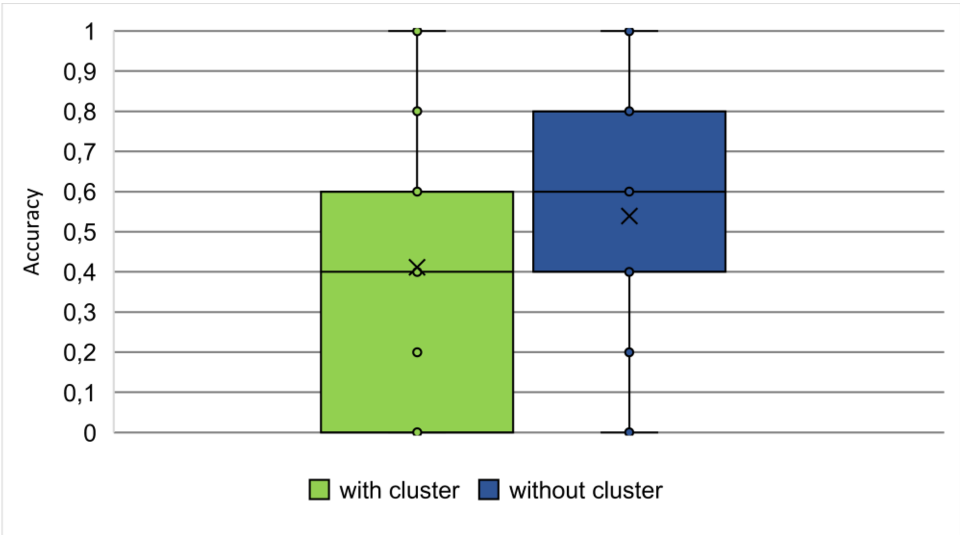

Fig 5: Proportion of correct answers in nonwords with either the presence or the absence of a noninitial cluster in DLD children. This figure represents the main effect of cluster. Accuracy was obtained dividing the number of correct responses by the number of items repeated. Overall, nonwords containing a cluster were repeated less accurately than nonwords which did not contain a cluster.

2. SIMULTANEOUS BILINGUALS

The next group examined in the study were simultaneous bilingual speakers of English and Czech who, at the time of testing, did not exhibit any signs of a developmental language disorder.

MODEL 1

A linear mixed effects model was carried out with length and age as fixed effects and accuracy as the dependant variable. Descriptive statistics for the model are depicted in Table 6.

Table 6: Descriptive statistics for syllable length accuracy in Simultaneous Bilinguals

	2 syllables	3 syllables	4 syllables	5 syllables
Mean (SE)	0,9 (0,04)	0,8 (0,05)	0,7 (0,05)	0,7 (0,05)
SD	0,14	0,19	0,18	0,17

The model showed a significant main effect of age, $t(9)=2.31$, $p = 0.04$ (Fig 5), a significant main effect of length in 2 and 3 syllable nonwords, $t(27)= -2.23$, $p = 0.03$ (Fig 6), and a marginal main effect in 3 and 4 syllable nonwords, $t(27)= -1.82$, $p = 0.07$. No other significant main effect or interaction was found during the analysis. An overview of the model output is presented below in Table 7.

Table 7: Summary of the linear mixed model effects for MODEL 1

	Estimate	**SE**	***dF***	**t value**	***p***
Intercept	0.79	0.03	9.00	20.94	< 0.001
Length1 3-2 syl	- 0.10	0.04	27.00	- 2.23	0.03
Length1 4-3 syl	- 0.08	0.04	27.00	- 1.82	0.07
Length1 5-4 syl	- 0.03	0.04	27.00	- 0.81	0.42
Age	0.01	0.004	9.00	2.31	0.04
Length1 3-2 syl : Age	0.005	0.005	27.00	1.11	0.27
Length1 4-3 syl : Age	- 0.001	0.005	27.00	- 0.33	0.74
Length1 5-4 syl : Age	0.0004	0.005	27.00	0.08	0.93

SE standard error, *dF* degrees of freedom, *Length1* 2,3,4,5 syllable nonwords

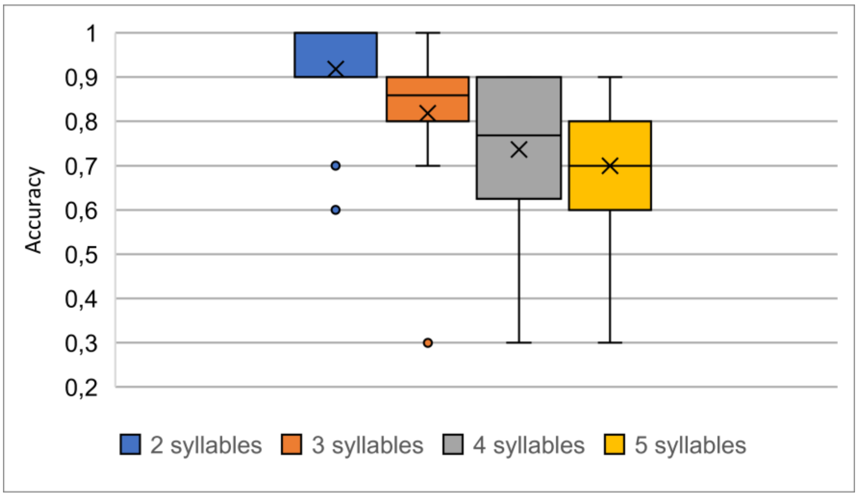

Fig 6: Proportion of correct answers in all examined nonword lengths in Simultaneous Bilinguals. This figure represents the main effect of length in 2 and 3 syllable words. Overall, nonwords with 2 syllables were repeated more accurately than nonwords with 3 syllables. The figure also depicts the marginal effect of length in 3 and 4 syllable words. Accuracy was obtained dividing the number of correct responses by the number of items repeated.

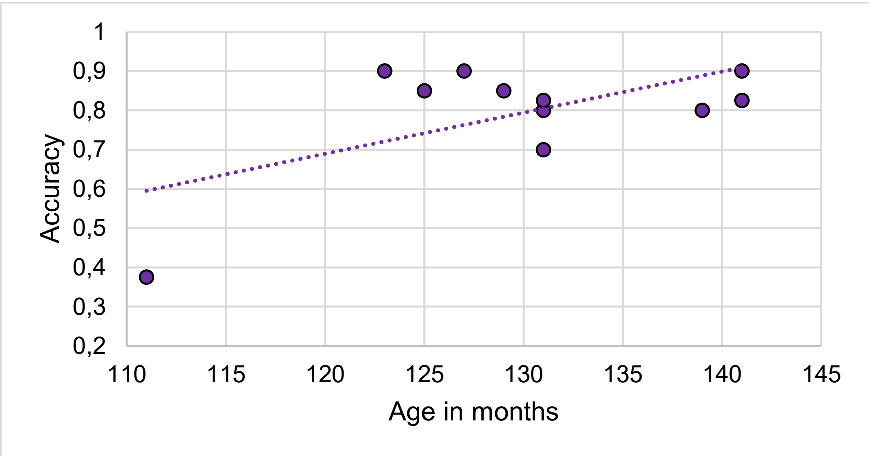

Fig 7: Proportion of correct answers across different ages in Simultaneous Bilinguals. This figure represents the main effect of age. Overall, as age increases, so does the proportion of correct answers. Accuracy was obtained dividing the number of correct responses by the number of items repeated.

MODEL 2

The second portion of the Simultaneous Bilingual group analysis focused on the participants' performance in long nonwords with the presence and absence of noninitial clusters. A linear mixed effects model was carried out with length, age, and cluster as fixed effects, and accuracy as the dependant variable. The model did not show any significant main effect. However, the model did show an interaction of cluster and length, $p = 0.01$ (Fig 8), and an interaction of cluster and age, $p = 0.03$ (Fig 9). No other significant interaction was found. An overview of the model output can be found below in Table 8.

Table 8: Summary of the linear mixed model effects for MODEL 2

	Estimate	**SE**	**dF**	**t value**	***p***
Intercept	7.863e-01	2.547e-02	3.600e+01	30.87	< 0.001
Length2	2.726e-02	5.094e-02	3.600e+01	0.53	0.5
Cluster	8.972e-03	5.094e-02	3.600e+01	0.17	0.8
Age	2.382e-03	3.042e-03	3.600e+01	0.78	0.4
Length2 : Cluster	2.727e-01	1.019e-01	3.600e+01	2.67	0.01
Length2 : Age	9.434e-04	6.084e-03	3.600e+01	0.15	0.8
Cluster : Age	1.311e-02	6.084e-03	3.600e+01	2.15	0.03
Length2 : Cluster : Age	9.434e-05	1.217e-02	3.600e+01	0.008	0.9

SE standard error, *dF* degrees of freedom, *Length2* 4,5 syllable nonwords

Note: The R interface displayed a message *boundary (singular) fit: see ?isSingular* signalling that even though the model fits the data, the random effects are very small. The model therefore displays nonstandard values of Estimate, SE and dF.

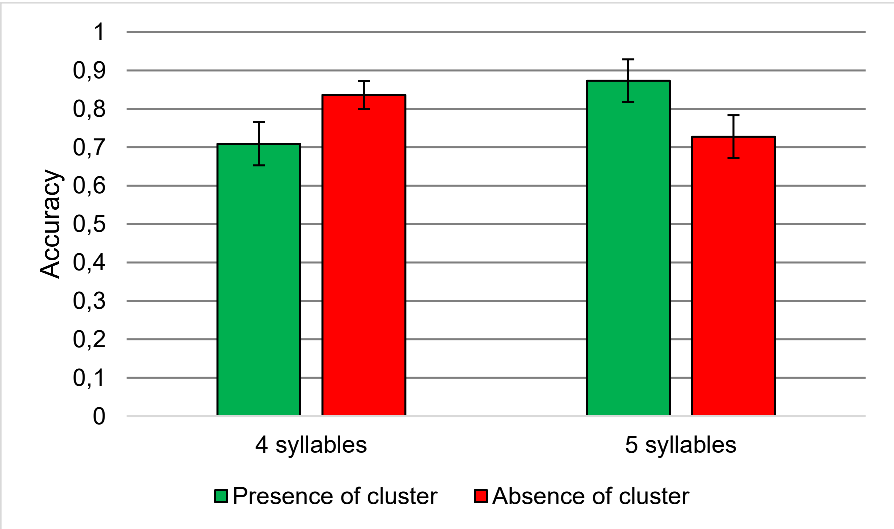

Fig 8: Proportion of correct answers in nonwords with and without clusters across different syllable lengths in Simultaneous Bilinguals. This figure represents the interaction between length and the presence or absence of cluster. In 4 syllable words, words without clusters are repeated more accurately. In 5 syllable words, words without clusters are repeated more accurately. Accuracy was obtained dividing the number of correct responses by the number of items repeated.

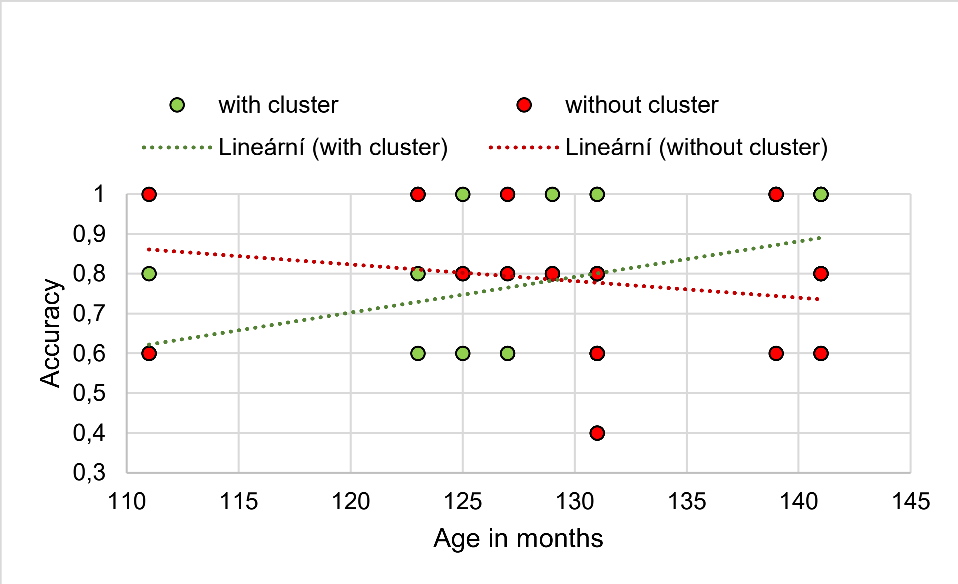

Fig 9: Proportion of correct answers in nonwords with and without clusters across different ages in Simultaneous Bilinguals. This figure represents the interaction between age and the presence or absence of cluster. The interaction is represented by the different slope of the two lines. In nonwords with a presence of cluster, the accuracy of the performance increases with age. In nonwords that do not contain a cluster the accuracy decreases with age. Accuracy was obtained dividing the number of correct responses by the number of items repeated.

Note: Certain items of the scatterplot overlap due to identical performance and age of some participants.

3. SEQUENTIAL BILINGUALS

The last examined group comprised of sequential bilingual speakers of Czech and English who, at the time of testing, did not exhibit any signs of a developmental language disorder.

MODEL 1

A linear mixed effects model was carried out with length and age as fixed effects, and accuracy as the dependant variable. Descriptive statistics for said model are shown in Table 9.

Table 9: Descriptive statistics for syllable length accuracy in Sequential Bilinguals

	2 syllables	3 syllables	4 syllables	5 syllables
Mean (SE)	0,9 (0,02)	0,8 (0,02)	0,8 (0,02)	0,6 (0,02)
SD	0,10	0,10	0,13	0,14

The model showed a significant main effect of length in 3 and 4 syllable words, $t(62)= -2.31$, $p = 0.02$, and a significant main effect of length in 4 and 5 syllable words, $t(62)= -3.40$, $p = 0.001$ (Fig 10). No other main effect or interaction reached significance in the analysis. An overview of the model output is presented below in Table 10.

Table 10: Summary of the linear mixed model effects for word MODEL 1

	Estimate	**SE**	***dF***	**t value**	***p***
Intercept	0.81	0.01	21.00	55.72	< 0.001
Length1 3-2 syl	- 0.008	0.03	62.99	- 0.24	0.8
Length1 4-3 syl	- 0.08	0.03	62.99	- 2.31	0.02
Length1 5-4 syl	- 0.12	0.03	62.99	- 3.40	0.001
Age	0.002	0.001	21.00	1.26	0.22
Length1 3-2 syl : Age	0.001	0.003	62.99	0.31	0.75
Length1 4-3 syl : Age	- 0.0004	0.003	62.99	- 0.10	0.91
Length1 5-4 syl : Age	0.003	0.003	62.99	0.99	0.32

SE standard error, *dF* degrees of freedom, *Length1* 2,3,4,5 syllable nonwords

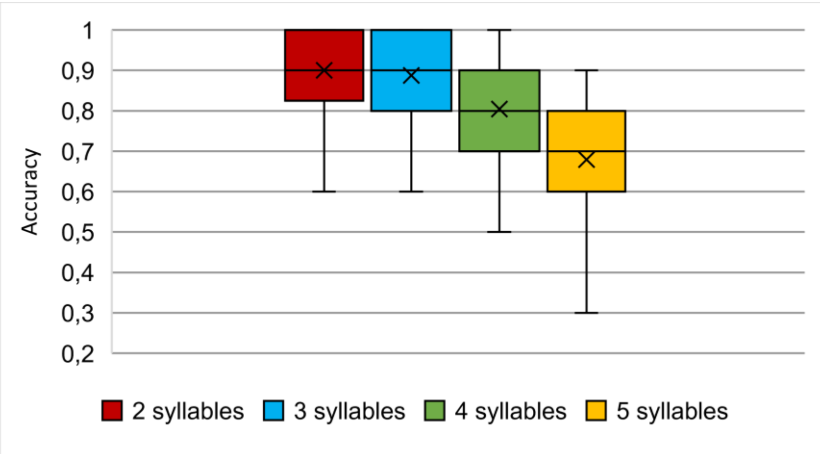

Fig 10: Proportion of correct answers in all examined nonword lengths in Sequential Bilinguals. This figure represents the main effect of length in 3 and 4 syllable nonwords. Overall, nonwords with 3 syllables were repeated more accurately than nonwords with 4 syllables. The figure also shows the main effect of length in 4 and 5 syllable nonwords. Overall, nonwords with 4 syllables were repeated more accurately than nonwords with 5 syllables. Accuracy was obtained dividing the number of correct responses by the number of items repeated.

MODEL 2

The second portion of the Sequential Bilingual group analyses focused on the participants' performance in long nonwords with the presence and absence of noninitial clusters. A linear mixed effects model was carried out with length, age and cluster as fixed effects, and accuracy as the dependant variable. The model showed a significant main effect of length, $t(63)= -2.81$, $p = 0.006$ (Fig 11) and a main effect of cluster, $t(63) = -2.34$, $p = 0.02$ (Fig 12). The model did not show any other significant main effect, nor any significant interaction. An overview of the model output can be found below in Table 11.

Table 11: Summary of the linear mixed model effects for word MODEL 2

	Estimate	**SE**	**dF**	**t value**	***p***
Intercept	0.74	0.02	21.00	30.87	< 0.001
Length2	- 0.10	0.03	63.00	- 2.81	0.006
Cluster	- 0.08	0.03	63.00	- 2.34	0.02
Age	0.002	0.002	21.00	0.92	0.3
Length2 : Cluster	0.01	0.07	63.00	0.23	0.8
Length2 : Age	0.002	0.004	63.00	0.51	0.6
Cluster : Age	0.003	0.004	63.00	- 0.75	0.4
Length2 : Cluster : Age	0.006	0.008	63.00	0.80	0.4

SE standard error, *dF* degrees of freedom, *Length2* 4,5 syllable nonwords

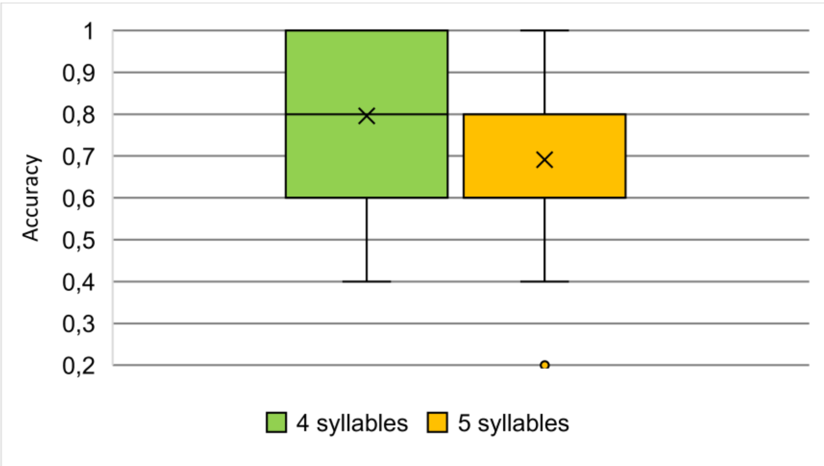

Fig 11: Proportion of correct answers in nonwords with 4 and 5 syllables in Sequential Bilinguals. This figure represents the main effect of length. Accuracy was obtained dividing the number of correct responses by the number of items repeated. Overall, nonwords with 4 syllables were repeated more accurately than nonwords with 5 syllables.

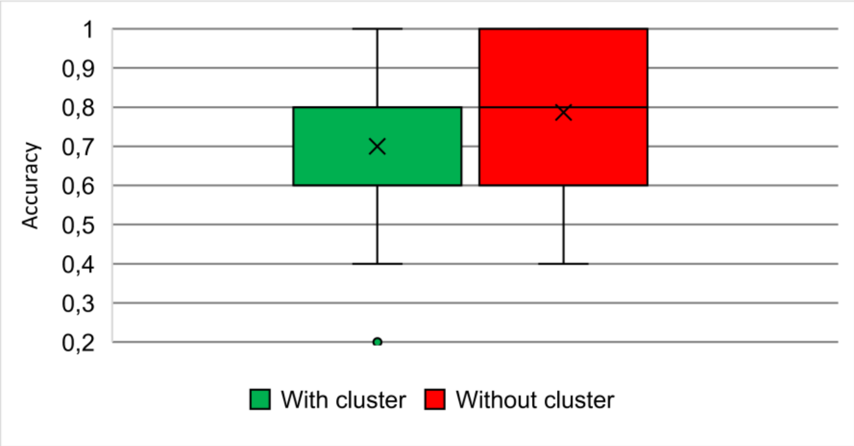

Fig 12: Proportion of correct answers in nonwords with either the presence or the absence of a noninitial cluster in Sequential Bilinguals. This figure represents the main effect of cluster. Accuracy was obtained dividing the number of correct responses by the number of items repeated. Overall, nonwords containing a cluster were repeated less accurately than nonwords which did not contain a cluster.

DISCUSSION

The aim of this project was to analyse patterns present in NWR performance of Czech-English bilingual children and monolingual English children with DLD. Due to the phonological nature of the study, simultaneous and sequential bilinguals were examined separately, as some variation in their performance caused by the contribution of their varying ages of onset was expected.

Firstly, the discussion will focus on the DLD group's performance. The performance of the DLD group was not at ceiling in either syllable length, as was anticipated. The participants did therefore prove to struggle with the CNRep task. This result is in line with various studies published since the development of CNRep. Examining firstly the descriptive statistics obtained from MODEL 1 which compared different syllable lengths, it seems that accuracy in the DLD participants decreases with the increase of the length of the repeated nonword (Table 3). This decrease in performance accuracy based on syllable length is most likely caused by the limited capacity of DLD children to form and hold accurate phonological representations in their working memory, as presented by Gathercole (1994). Gathercole (1994) explains the effect of length as a manifestation of an impairment of the phonological loop – a temporary storage of an unfamiliar phonological sequence. Similarly to the results of the present study, Archibald (2006) reports the highest stuggle of nonword repetition in DLD children in 5 syllable nonwords, and links this finding to a deficit in short-term working memory: "in line with a short-term memory account of the deficit, the (DLD) group had more difficulty holding novel phonological forms in mind as reflected by the increased magnitude of their repetition impairment for longer nonwords" (Archibald, 2006, p. 11).

The output of MODEL 1 showed a main effect of age (Fig 2). With the increase of age, the children showed a significantly higher overall accuracy scores. In other words, the CNRep task gradually becomes easier for children, as they grow older. It is importnant to note that the age range of the DLD group examined in this study was quite wide, spanning from 5 to 14 year old participants. This quite heterogenous group (considering the age of the participants) may therefore have had varying levels of exposure to language. The much younger participants may have been exposed to language singificantly less than their older counterparts, therefore the effect of age in nonword repetition could be linked to the children's existing knowledge of language. Snowling (1991) links NWR performance accuracy to language knowledge:

“nonword repetition is a complex psycholinguistic task that undoubtedly engages a child's existing knowledge of the phonological, including prosodic, structure of language” (p. 3). The possible varying degrees of exposure to language may have therefore contributed to this result. However, an overall increase of working memory function with age has also been proven (Henry, 1993; Gathercole, 1994), so this result may perhaps also reflect the improvement in the short-term memory phonological loop in older participants. Older children with DLD may, as opposed to younger children, accurately perform rehearsals of unknown sequences in their phonological loop before repeating the nonword. MODEL 1 in DLD children also reported an interaction between age and length in 4 and 5 syllable nonwords. In both 4 and 5 syllable nonwords, accuracy significantly increased with age (Fig 3). As 4 and 5 syllable nonwords represent the more difficult portion of the test, it is logical that the effect of age would be strong in these items. The age effect increases at a higher rate within the 5 syllable nonwords than within the 4 syllable nonwords. In other words, the accuracy of 5 syllable nonword repetition improves the most with age. This finding could yet again be tied to the notion of working memory improving with age. The 5 syllable nonwords put the most demand on working memory – children are required to store a long sequence, often containing complex phonological structures, with both a primary and secondary stress placements, putting a higher demand on the functions of the phonological loop. Therefore, in these items, the effect of age (relating to improvement of working memory and possibly to higher language exposure) proves to be the most evident.

The second portion of the DLD group analysis carried out using MODEL 2 compared accuracy in 4 and 5 syllable nonwords with and without noninitial consonant clusters. This model examined the relationship of syllable length in longer nonwords and phonological complexity of the nonword in relation to performance accuracy. The results showed a main effect of cluster (Fig 5), meaning that nonwords which contained a cluster proved significantly harder to repeat than nonwords which did not. Similarly, Archibald (2006) examined the CNRep performance of both TD and DLD children in nonwords with and without clusters and found that the DLD participants exhibited a significant decline in accuracy in words with consonant clusters. Archibald (2006) states two possible exlanations for the influence of clusters on the DLD performance, first being that children with DLD “may have less robust phonological representations for these relatively uncommon phoneme combinations” (p. 11), or secondly, they might “have difficulty forming the novel phonological sequences required in nonword repetition” (p. 11). This finding of poorer CNRep performance in nonwords containing noninitial clusters is also supported by Cilibrasi (2018) who, similarly to this study, examined the performance in 4 and 5 syllable nonwords with and without clusters. Cilibrasi (2018) reports that both TD and DLD children showed a difficulty in repeating nonwords containing clusters, and therefore suggests that the presence of clusters "contributes to the number of errors made by children in long nonwords" (p. 9). Both studies, however, present a conflicting approach to decreased cluster accuracy as a marker of DLD. According to Archibald (2006), the presence of clusters makes nonword repetition significantly more difficult only for DLD children (not TD children). Contrastingly, Cilibrasi (2018) reports that both TD and DLD children performed more poorly in nonwords with clusters, and he therefore considers this finding as general, rather than DLD specific.

Additionally, MODEL 2 reported a main effect of length (Fig 4), meaning that 5 syllable words were significantly more difficult for DLD children to repeat than 4 syllable words, and a marginal main effect of age (= overall accuracy increased in older participants). Both of these effects were already discussed in the previous section.

Summarizing briefly the patterns of performance of the DLD group tested in this study, we can conclude that the participants were significantly affected by age, especially in longer nonwords, and that the presence of cluster proved to make the repetition of the nonwords significantly more difficult, in both 4 and 5 syllable nonwords.

I will now separately adress the performance of both of the bilingual groups. Before I begin to discuss the results of this study, it is important to note that several existing studies have already drawn implications of age of onset on bilingual NWR performance. Summers (2009) reported that nonword repetition accuracy correlated with age of onset of the second language in bilingual participants – children with later age of onset exhibited overall worse performance accuracy scores in a NWR task modeled after their second language, as opposed to children with earlier age of onset, who appeared to have significantly less problems with the task. A number of studies links bilingual NWR performance accuracy in the non-dominant language to the amount of language experience (Summers, 2009; Gutiérrez-Clellen, 2010; Lee, 2012; Core, 2017). It was therefore expected that both of the bilingual groups examined in this study would vary in performance accuracy, perhaps also in performance patterns.

I will now analyse in further detail the performance of simultaneous bilinguals, i.e. the group of bilinguals who have started acquiring both Czech and English at the same time (= at birth). Looking firstly at the descriptive statistics obtained from MODEL 1, we can observe the declining tendency of accuracy with the increasing number of syllables of the repeated item (Table 6). Focusing more closely at the MODEL 1 result, we can observe a significant effect of length, but only in 2, 3, and 4 syllable nonwords (Fig 6). Nonwords containing 3 syllables were significantly more difficult than nonwords containing 2 syllables, and similarly, nonwords containing 4 syllables were significantly more difficult than nonwords containing 3 syllables. The effect of length in 5 syllable nonwords did not reach significance in the analysis, as 5 syllable nonwords did not prove to be significantly more difficult to repeat than 4 syllable nonwords. This result somewhat parallels the pattern found in typically developing monolingual children tested using CNRep by Gathercole (1994). Gathercole (1994) found that monolingual children's performance declined significantly with length, but only up to 4 syllables. In Gathercole (1994), TD monolingual children's repetition of 5 syllable nonwords was better than that of 4 syllable nonwords. Gathercole (1994) attributes this result to a high percentage of functional morphemes found in 5 syllable nonwords, such as 'altup*atory*', 'confran*tually*' 'defermi*cation*', which might facilitate the segmentation and storing of the items. "The presence of these familiar morphological and phonological multisyllabic sequences, which are present in many words likely to be familiar to young children, may have offset the decline in accuracy of maintaining increasingly lengthy phonological sequences in working memory" (Gathercole, 1994, p. 8). Based on the result obtained in the present study and the results from Gathercole (1994), it could be argued that in terms of length effects, simultaneous bilinguals could exhibit a similar behaviour to typically developing monolingual children. As simultaneous bilinguals are, just like monolinguals, exposed to English from birth, the functional morphemes can perhaps prove to be facilitatory to the repetition of 5 syllable CNRep items which contain a high number of these morphemes. Another significant effect in simultaneous bilinguals found via MODEL 1 was the effect of age (Fig 7). The effect of age could be, as in the previously discussed DLD group, attributed to either the gradual improvement of working memory in childhood, or to the gradually increasing exposure of language. The increased accuracy in bilingual NWR performance with the increase of age has been previously reported by Santos (2006).

Second portion of the simultaneous bilingual analysis carried out using MODEL 2 compared accuracy in 4 and 5 syllable nonwords with and without noninitial consonant clusters. This model examined the relationship of syllable length in longer nonwords and phonological complexity of the nonword in relation to performance accuracy. The model did not show any significant main effect, so there was not a significant main effect of either length, or age, or cluster. There were, however, several interactions found. The first interaction was between nonword length and the presence or absence of cluster (Fig 8). The simultaneous bilingual participants repeated 4 syllable words more accurately, when there was not a cluster present in them, and the performance accuracy was lower for 4 syllable words that did contain a cluster. This result is in line with previous findings in terms of how clusters can affect nonword repetition performance (Archibald, 2006; Cilibrasi, 2018). However, an interesting pattern emerges with 5 syllable nonwords. The 5 syllable nonwords were repeated more accurately, when there was an absence of cluster, and less accurately, when there was a presence of cluster. The pattern of this result contrasts completely the findings of Cilibrasi (2018) in monolingual chidlren, where the presence clusters influenced the performance of both TD and DLD groups in a negative way. However, Archibald (2006) reports that only in the monolingual DLD group (=not the TD monolingual group) there was a decline in performance in nonwords containing clusters. In this respect, we could perphaps theoretize that simultaneous bilingual performance mirrors that of typically developping monolinguals. As there was a contradictory tendency in 4 and 5 syllable nonwords, we cannot draw the conclusion that simultaneous bilinguals struggled more in words that placed a higher demand on their articulatory output, nor can we conclude that they struggled with phonological representations for more complex phoneme combinations. It is important to note that although the model accounted for individual differences, the size of the sample was relatively small – therefore in order to reach a conclusion in the matter of simultaneous bilingual CNRep performance and phonological complexity, a further analysis using a larger sample of simultaneous bilinguals would be needed. A further analysis of the 5 syllable items that were overall more / less problematic could also prove beneficial in this case. Refering to Gathercole's (1994) remark on the notion of familiar morphemes present in 5 syllable words, I would suggest that following studies further examine the interference between two varying influences – clusters and familiar morphemes. As these familiar morphemes are present largely in 5 syllable nonwords and not in 4 syllable nonwords, the presence of familiar morphemes could have facilitated the repetition of certain 5 syllable nonwords containing consonant clusters. The results of MODEL 2 for simultaneous bilinguals showed another interaction – that is the interaction of age and cluster (Fig 9). In nonwords with the presence of cluster, performance accuracy significantly improved with age, which is a pattern to be generally expected in nonword repetition tasks, as both working memory fuctions and language exposure gradually grow during childhood. However, in words not containing clusters the accuracy in the simultaneous bilingual group slightly decreased with age. It could again be argued here that this result was possibly obtained due to a small sample size of the examined group, therefore a further examination in future studies is suggested.

Summarizing briefly the findings in simultaneous bilinguals, we can conclude that, in several aspects, the patterns of their performance deviated from certain previous findings in CNRep performance of both TD and DLD monolingual children. In some aspects (that is notably the effect of syllable length and cluster), their performance mirrored slightly previous findings by Archibald (2006) in monolingual TD performance. It could be argued that simultaneous bilinguals should not be massively disadvanteged in CNRep assessment.

I will now analyse in further detail the performance of sequential bilinguals, i.e. group of bilinguals who have started acquiring their second language (English) later than their dominant language (Czech). The acquisition of English in sequential participants began sometime during 1 year to 4 years of age – only after the children's phonemic inventory had already narrowed to phonemes relevant to their dominant language (in this case: Czech). Before I begin the analysis, a remark could be made about the previously discussed link between NWR performance and overall language abilities, including vocabulary knowledge (Botting, 2001; Gathercole, 1994; Gathercole 1999). Sequential bilinguals will possibly face limitations due to the later age of onset and smaller vocabulary size, so certain implications for patterns in NWR performance deviating from monolingual performance patterns are expected. Looking firstly at the descriptive statistics obtained from MODEL 1, we can observe the declining tendency of accuracy with the increasing number of syllables of the repeated item (Table 9, Fig 10). In fact, the model found a main effect of length in 3, 4, and 5 syllable nonwords. The 4 syllable nonwords were significantly more difficult than 3 syllable nonwords, and 5 syllable nonwords were significantly more difficult than 4 syllable nonwords. The effect of length was not observed between 2 and 3 syllable nonwords. This result subverts the finiding of Thordardottir (2013) who reported that "bilingual children with varying levels of exposure were unaffected by the length of nonwords" (p. 1). The present study shows that sequential bilinguals appear to be influenced by the number of syllables, most notably in longer nonwords. MODEL 1 did not show any other main effect or interaction – no effect of age in sequential bilinguals was found. For sequential bilingual participants, CNRep does not appear to become easier with age.

The second portion of the sequential bilingual analysis carried out using MODEL 2 compared accuracy in 4 and 5 syllable nonwords with and without noninitial consonant clusters. This model examined the relationship of syllable length in longer nonwords and phonological complexity of the nonword in relation to performance accuracy. The model found two main effects. Firstly, the model found the main effect of length (Fig 11) which was already discussed in relation to MODEL 1. Secondly, MODEL 2 reported a significant effect of cluster. In both 4 and 5 syllable nonwords, the presence of cluster appeared to worsen the performance of the sequential bilingual group. For the sequential bilinguals it appears that the presence of complex phonological structures influences negatively nonword repetition. The possible explanation of this effect could be the disadvantage caused by the phonemic inventory of sequential bilinguals (which started to develop only after the narrowing of their perceptual abilities to features found in their dominant language). Another possible cause for the effect of cluster could be the higher demand on articulatory output needed for uttering these complex structures.

Summarizing briefly the patterns of performance of the sequential bilingual group analysed in this study, a conclusion can be drawn that the participants were significantly affected by length (effect found in 3, 4, and 5 syllable nonwords) and that the presence of cluster proved to make the repetition of the nonwords significantly more difficult, in both 4 and 5 syllable nonwords.

While I could not make a comparison between groups using a statistical analysis due to the difference in age and sample size of the groups, a descriptive comparison of the various patterns may offer some insights into the DLD and bilingual performance. It seems that DLD participants were highly influenced by age in their performance. The same can be said for simultaneous bilinguals, however this effect was not found in sequential bilinguals. When looking at the effects of length in all groups, slightly varying patterns can be observed. In the DLD group, the effect of length was the most prevalent in 4 and 5 syllable nonwords. Similarly, in the sequential bilingual group, the effect was prevalent in 3, 4, and 5 syllable nonwords. A group that displays a contrasting pattern to the other groups in the respect of the effect of length is the simultaneous bilingual group. For simultaneous bilinguals the effect was present only in 2, 3, and 4 syllable nonwords. Simultaneous bilinguals were seemingly not affected by length in the longer nonwords of the CNRep task. Looking at the patterns of performance in words with regards to phonological complexity, it seems that for both DLD and sequential bilinguals, the presence of cluster generally influenced performance accuracy in a negative manner. In this respect, the simultaneous bilingual group showed another contrasting pattern. The effect of cluster was not as clear cut in their performance as it was for the other two groups (4 syllable nonwords containing clusters were repeated less accurately, but 5 syllable nonwords containing clusters were repeated more accurately).. These findings suggest that when assessing whether bilingual children exhibit signs of DLD, we should take into consideration their age of onset. It seems that when examining the patterns of length and cluster in addition to a simple 0-1 scoring system, CNRep in its current form could prove useful when assessing simultaneous bilinguals, as the patterns found in their performance varied from the patterns found in DLD. However, sequential bilingual and DLD groups showed a similarity of patterns. It would therefore be difficult to determine whether their CNRep performance is influenced by bilingualism or DLD. The findings of this study do not support CNRep testing as the sole measure of recognising DLD in bilingual children with a later onset of birth, even if we were to analyse the patterns in length and cluster performance.

I will now adress the limitations of the study. Firstly, it needs to be acknowledged that the samples were relatively small in size and that the age range was different for each group. This did not allow for a post-hoc statistical assessment of the data across all 3 groups, therefore no strong claims can be made with regards to the obtained results. A further investigation would need to examine the performance in a larger sample of participants who have been properly age matched. This study was completed during the Covid pandemic, and while I made arrangements with international schools for testing bilingual participants age matched with the DLD group, these plans were unfortunatelly cancelled twice in the span of 6 months due to restrictive measures imposed by the government. Following these issues and delays, I have made the decision to use previously obtained data which was available to complete the present study, at the cost of having poorly matched samples.

This also means that all of the data was aquired for purposes different than the present study – the DLD data was acquired as part of a clinical assessment, and the bilingual data was acquired during background testing for a project which did not place its main focus on nonword repetition. Due to the acquisition of data for purposes different than the present study, not all relevant information was available – for example it was not clear in which part of the word the participants struggled. The present study worked only with an accuracy score for each nonword – either 0 points for incorrect repetition of the full item, no matter the error; or 1 point for the correct repetition of the entire item. This did not allow for an in depth analysis of errors – the present study attempted to merely observe certain patterns in performance, based on a chosen categorization of items. Futher investigation focused on the categorazation of errors would definitely shed more light onto the problem of disentangling the effects of DLD and bilingualism in CNRep performance. Gathercole (1994) presents a classification of errors made in CNRep performance: commonly made errors divided into categories, including phoneme substitution, phoneme deletion, transposition, lexicalisation, etc. A further investigation could statistically analyse the proportion of these error types in DLD and bilingual performance, in search for possible varying patterns of errors in NWR performance.

CONCLUSION

The aim of this study was to analyse in more detail the performance of bilingual children and children with developmental language disorder in a nonword repetition task, specifically in The Children's Test of Nonword Repetition (Gathercole, 1994). As both of these groups have been proven by previous research to exhibit below average performance, the present study attempted to analyse their performance in order to observe possible diverging patterns within each group.

For the analysis, previously obtained CNRep data was used. The first sample of data consisted of clinically tested monolingual children diagnosed with a developmental language disorder. The second and third samples of data consisted of Czech-English bilingual children. The bilingual participants were further divided into two groups, based on the age of onset of the second language (= simultaneous bilinguals and early sequential bilinguals). The data for each of the experimental groups was analysed separately, due to the mismatch in sample size and ages of the participants.

The CNRep stimuli were divided into several conditions for the analysis, and two statistical models were created to examine the data. The data was analysed using a linear mixed effects model which accounted for random effects of participant. For each of the chosen conditions, accuracy on a scale of 0 to 1 was counted (i.e. score 0 if no item was repeated accurately, score 0,5 if half of the items were repeated accurately, etc). The first analysis, including all nonword lengths, had age and length as predictors. The second analysis, including only longer nonwords, had age, length, and cluster as predictors.

After examining the patterns of performance, we can conclude that participants with DLD were significantly affected by age, especially in 4 and 5 syllable nonwords, and that the presence of clusters made the repetition of nonwords significantly more difficult (no matter how long the nonwords were).

The group of simultaneous bilinguals exhibited slightly different patterns to the DLD group. Simultaneous bilinguals were seemingly not affected by length in 4 and 5 syllable nonwords. Additionally, the effect of cluster was not clear-cut for the simultaneous bilinguals – whether the accuracy was impacted negatively or positively by the presence of clusters was connected to the nonword length (in 4 syllable items, the nonwords containing clusters were repeated less accurately, whearas in 5 syllable items, the nonwords containing clusters were repeated more accurately).

The sequential bilingual group was (similarly to the DLD group) affected by length in long nonwords. As in the DLD group's performance, the presence of cluster negatively impacted the performance in all examined word lengths.

Thus, a conclusion can be drawn that while looking at patterns of performance (namely length and cluster effects) could prove useful when assessing simultaneous bilinguals for DLD, the same cannot be said for sequential bilinguals, as the patterns emerging from sequential bilingual performance mirrored the patterns found in DLD performance. Overall, the findings of this study do not support the use of CNRep as the sole determining assessment for DLD in bilingual children.

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RESUMÉ

Cílem této práce bylo zmapovat výkon bilingvních dětí a dětí s vývojovou poruchou řeči v testech opakování pseudoslov. Test opakování pseudoslov se běžně užívá jako jeden z prostředků sloužících k odhalení vývojové poruchy řeči (developmental language disorder = DLD) u dětí kolem čtvrtého až desátého roku, jelikož děti s vývojovou poruchou řeči mají sklony k podprůměrným výsledkům v tomto typu testu. Problém však nastává při diagnóze bilingvních dětí. Jelikož testy opakování pseudoslov byly vyvinuty k měření charakteristik monolingvního jazykového vývoje, je těžké pouze za použití opakování pseudoslov určit, zda bilingvní dítě trpí vývojovou řečovou poruchou. Jelikož je jazykový vývoj bilingvních dětí odlišný, mají tyto děti sklony k podprůměrným výsledkům v testech opakování pseudoslov. Na základě výsledku tohoto typu testu může docházet k nesprávné diagnóze bilingvního dítěte i v případě, že ve skutečnosti žádnou řečovou patologii nevykazuje. Na druhou stranu také může docházet k podceňování případných řečových problémů bilingvních dětí jen proto, že jsou bilingvní. Velmi často klinicky užívaným testem opakování pseudoslov používaným k diagnóze dětí je The Children's Test of Nonword Repetition (CNRep) vyvinut Gathercole (1994). Tato práce provádí hlubší analýzu výsledků testu CNRep u monolingvních dětí s řečovou poruchou a bilingvních dětí nevykazující řečové patologie, za účelem observace chování těchto dvou skupin. Tato práce se pokouší o zmapování výkonů těchto dvou skupin.

Pro porozumění problematiky testu opakování pseudoslov u dětí je třeba se nejprve zaměřit na průběh akvizice jazyka v monolingvních podmínkách, v bilingvních podmínkách, a v patologických podmínkách. Tato práce se zaměřuje zejména na osvojování fonologie, jelikož test opakování pseudoslov hodnotí právě fonologické schopnosti testovaných subjektů.

Akvizice jazyka u dětí nastává automaticky, bez explicitního procesu učení. Děti z různých sociálních i jazykových prostředí si osvojují jazyk na podobné bázi (Guasti, 2016). Existují dva odlišné náhledy na akvizici jazyka, jeden na základně teorie vrozenosti (Universal Grammar – Chomsky, 1981) a druhý na základě postupného objevení jazykových schopností (učení skrze analogii – Tomasello, 2003). Oba přístupy však pracují se základním konceptem „citlivého období" – tj. období, ve kterém musí proběhnout určitý vývoj, jinak akvizice dané schopnosti nebude možná vůbec, a to kvůli nervovým okruhům v našem mozku (Lenneberg, 1967). K důležitosti citlivého období v akvizici fonologie se brzy vrátíme.

Akvizice fonologie u dětí začíná bezprostředně po narození. Předchozí výzkum dokazuje, že již 4-denní dítě je schopné rozeznat výpovědi v mateřském jazyce od výpovědí v jazyce jiném, a to na základě rytmické organizace jazyka, tj. na základě distribuce samohlásek a souhlásek (Mehler, 1988). Nemluvňata započínají svůj fonologický vývoj s kapacitou, naučit se fonémy jakéhokoli jazyka. V následujících měsících života zužují svou vnímavost pouze na zvuky patřící do fonémického soupisu jejich mateřského jazyka. Toto zužování započíná kolem šestého měsíce života, a je plně realizováno kolem měsíce dvanáctého. Jako příklad si můžeme uvést studii zkoumající mluvčí japonštiny a jejich schopnost rozlišit hlásky /r/ a /l/, které se ve fonémickém soupisu japonštiny nevyskytují jako samostatné fonémy. Tsushima (1994) ukazuje, že ačkoli šesti měsíční nemluvňata byla schopna tyto dvě hlásky rozlišit, dvanácti měsíční nemluvňata už tuto schopnost neprokázala. Fonologická produkce začíná kolem šestého měsíce života, kdy děti vykazují cvičnou fázi žvatlání („babbling phase“). Jejich žvatlání nejprve zahrnuje univerzální znaky, avšak kolem osmého až desátého měsíce se žvatlání začíná podobat zvukům, které lze naleznout v mateřském jazyce dítěte (Boysson-Bardies, 1989). Kolem dvanáctého měsíce začínají děti produkovat první smysluplná slova (Guasti, 2016).

Jeden ze způsobů k monitorování fonologického vývoje u dětí jsou testy opakování pseudoslov, ve kterých děti slyší neznámé vymyšlené slovo, a musí jej zopakovat. Podprůměrné výsledky v testech opakování pseudoslov mohou mít různé implikace. Podprůměrné výsledky mohou poukázat na problémy s percepcí a segmentací daného pseudoslova (Snowling, 1991), problémy s motorikou řeči, či problémy s krátkodobou pracovní pamětí (Gathercole, 1994). Výsledky testu opakování pseudoslov mohou také úzce souviset s dlouhodobou znalostí slovní zásoby daného jazyka (Rispens, 2012). Gathercole (1994) vyvinula test opakování pseudoslov určen specificky pro hodnocení anglicky mluvících dětí – The Children’s Test of Nonword Repetition (CNRep). CNRep se skládá ze čtyřiceti položek. Položky jsou rozděleny do 4 kategorií dle jejich délky (2, 3, 4, 5 slabičná pseudoslova). Všechny položky jsou fonotakticky a prosodicky přijatelné v anglickém jazyce. Dítě dostane jeden bod, zopakuje-li danou položku naprosto správně. Neudělují se částečné body, zopakuje-li dítě správně pouze část slova. Maximální počet bodů je tedy 40.

Akvizice jazyka u bilingvních dětí s sebou nese svá specifika. První specifikum spočívá v tom, že je velmi těžké bilingvismus jako takový nadefinovat. Definice bilingvismu se za poslední desetiletí výrazně proměnila. Bloomfield (1993) definoval bilingvismus jako zvládnutí dvou jazyků na úrovni rodilého mluvčího; Grosjean (1989) naopak definoval bilingvismus jako schopnost fungovat ve dvou jazycích. Dle Bialystok (2001) by se však bilingvismus neměl definovat jako jedna z dalších proměnných ve výzkumu, nýbrž jako škála znalosti dalšího jazyka. Avšak pro výzkumné účely je třeba bilingviály nějak klasifikovat. Tímto se vracíme ke konceptu citlivého období. Klasifikace bilingvních mluvčích je v mnohých případech určena podle doby, kdy se mluvčí začali učit druhý jazyk. Vzhledem k vývoji mozku bilingvních mluvčích, rozlišujeme dvě skupiny – simultánní a sekvenční. Simultánně bilingvní mluvčí se začínají učit druhý jazyk ve stejné chvíli jako první, tj. oba jazyky se učí od narození. Simultánně bilingvní mluvčí poznávají svět skrze oba jazyky, a akvizice jednotlivých řečových jevů probíhá tedy simultánně. Naproti tomu sekvenčně bilingvní mluvčí se začínají druhému jazyku učit později, tj. v momentě, kdy již disponují určitými jazykovými schopnostmi. Sekvenčně bilingvní mluvčí si tedy neosvojují oba jazyky ve stejnou dobu, ani stejným tempem (Baker, 2011).

Jak již bylo zmíněno, bilingvní akvizice jazyka probíhá jinak než akvizice monolingvní. Jelikož se většina dat v oblasti osvojování jazyka soustředí pouze na monolingvní vývoj, je třeba poukázat na určité rozdíly, a na problémy, které tento fakt přináší (Marinis, 2017). Výzkum se v minulosti zaměřoval na otázku, zda jsou bilingvní děti schopny odlišit od sebe dva dané jazyky, kterým se učí. Paradis (2001) zkoumala, zda bilingvní děti mají dva rozdílné fonologické systémy. Její výsledky ukázaly, že bilingvní děti skutečně disponují dvěma rozdílnými fonologickými systémy, avšak systémy se mohou navzájem ovlivňovat, a neexistují tedy zcela autonomně. Molnar (2014) také dokázala, že bilingvní nemluvňata stará 3,5 měsíců byla schopna rozlišit od sebe dva jazyky stejné rytmické kategorie (naproti tomu monolingvní nemluvňata rozlišují pouze jazyky patřící do jiné rytmické kategorie). Stinnými stránkami bilingvního vývoje jsou například zpoždění v osvojení inflekční morfologie a komplexní syntaxe. Bilingvní děti se také mohou potýkat s pomalejším vybavením slov. Může jim trvat delší dobu, než si vzpomenou na slovo, které chtějí říct, nebo než například vyjmenují slova příbuzná. Bilingvismus však přináší mnohé výhody v kognitivních oblastech (Pearl & Lambert, 1962). Mezi tyto výhody patří například velmi vysoké exekutivní funkce (Bialystok, 2004) a zlepšené sociální dovednosti (Liberman, 2016).

Jak již bylo zmíněno, bilingvní děti mají sklony k podprůměrným výsledkům v testech opakování pseudoslov. Gathercole (1999) připisuje tento fakt slovní zásobě. Summers (2009) zjistila, že u španělsko-anglických bilingviálů byl výsledek anglického testu opakování pseudoslov ovlivněn dobou, kdy se děti začaly angličtinu učit. Další studie (Lee, 2012) připisují výsledek míře znalosti jazyka. Lee (2012) také ve své studii říká, že bilingvní děti mohou vykazovat jiné chování v tomto typu testu (tj. jiné „vzorce" ve svých výsledcích).

Zaměřme se nyní na vývojovou poruchu řeči (developmental language disorder = DLD). Jedná se o poruchu, při které děti vykazují vadu řeči, nikoli však vadu kognitivních schopností. Tato patologická vada se však může vyskytovat u dětí, u kterých se zároveň vyskytuje například vada pracovní paměti, dyslexie, co ADHD. Příčiny vývojové poruchy řeči nejsou známy, bylo však dokázáno, že může být dědičná (Bishop, 1995). Friedmann a Novogrodsky (2008) dělí vývojovou poruchu řeči na několik podtypů – syntaktická, fonologická, lexikální, a pragmatická. Pro účely této práce se nyní budeme věnovat fonologickému podtypu vývojové poruchy řeči. Děti s fonologickým typem DLD mají problém se zpracováním fonologických vjemů, tj. ukládáním fonologické informace do krátkodobé paměti a znovu získáním fonologické informace z dlouhodobé paměti. Mají také problém s rozeznáním jednotlivých fonémů v mluveném projevu (Wagner & Torgesen, 1987). Děti s DLD mají tendenci k podprůměrným výsledkům v testech opakování pseudoslov, tudíž se tyto testy běžně používají k diagnostikování DLD.

Problém však nastává, pokoušíme-li se pomocí opakování pseudoslov diagnostikovat DLD u bilingvních dětí. Zejména u dětí, které se začaly učit druhý jazyk až později, a jejich fonologický vývoj v daném jazyce tak může být zpomalený. Bilingvní děti také mohou být ovlivněny vlivy z jazyka prvního. To vše přispívá k podprůměrným výsledkům v testu, který, dle standardizovaných monolingvních norem, tedy nemůže zcela jasně DLD diagnostikovat. Winsdor (2010) a další se přiklánějí k názoru, že test opakování pseudoslov není dostatečným ukazatelem DLD u bilingvních dětí. Tato práce analyzuje výkon v CNRep testu u dětí s DLD a dvou skupin bilingvních dětí (simultánní a sekvenční). Práce se soustředí na hlubší analýzu vybraných jevů výkonu (oproti běžně užívanému bodovému systému, který uděluje pouze finální počet bodů). Práce se soustředí na anglicky mluvící monolingvní děti s DLD a česko-anglicky mluvící bilingvní děti.

Zkoumány byly tři skupiny účastníků – anglicky mluvící monolingvní děti s DLD a česko-anglické simultánně bilingvní děti a česko-anglické sekvenčně bilingvní děti. Položky testu CNRep byly rozděleny do kategorií, pro každou podmínku byla spočítána přesnost odpovědí na škále od 0 do 1. Byly vytvořeny dva statistické modely pro analýzu dat. Pro první model byla použita všechna pseudoslova, která byla rozdělena do 4 kategorií podle počtu slabik. Pro druhý model byla použita pouze čtyř a pěti slabičná slova, která byla dále rozdělena do dvou kategorií podle toho, zda obsahovala či neobsahovala shluk souhlásek. Vzhledem k nepoměrným velikostem skupin a k rozdílným věkům účastníků byly skupiny analyzovány každá zvlášť.

Výsledky DLD skupiny ukázaly, že výkon byl silně ovlivněn věkem, tj. s vyšším věkem se signifikantně zlepšoval výkon v testu. Druhý model ukázal, že délka ve 4 a 5 slabičných položkách měla vliv na výkon, tj. přesnost opakování byla signifikantně nižší u 5 slabičných pseudoslov. Výsledky druhého modelu také ukázaly, že přítomnost shluku souhlásek výrazně ovlivnila přesnost opakování slov, tj. u slov ve kterých se nachází shluk souhlásek byla přesnost výrazně nižší. Výsledky simultánně bilingvní skupiny ukázaly, že délka signifikantně ovlivnila výkon pouze u 2 a 3 slabičných slov. Výsledky také ukázaly, že s vyšším věkem se zlepšila přesnost opakování. Druhý model u simultánně bilingvní skupiny ukázal interakci mezi délkou pseudoslova a přítomností shluku souhlásek. U čtyř slabičných slov byla přesnost opakování vyšší ve slovech, které neobsahovaly shluk souhlásek. U pěti slabičných slov tomu však bylo opačně, tj. přesněji byla opakována slova, která shluk souhlásek obsahovala. Výsledky sekvenčně bilingvní skupiny poukázaly na signifikantní efekt délky ve 3, 4 a 5 slabičných položkách. Druhý model ukázal, že délka ve 4 a 5 slabičných položkách měla vliv na výkon, tj. přesnost opakování byla signifikantně nižší u 5 slabičných pseudoslov. Výsledky druhého modelu také ukázaly, že přítomnost shluku souhlásek výrazně ovlivnila přesnost opakování slov, tj. u slov ve kterých se nachází shluk souhlásek byla přesnost výrazně nižší.

V poslední kapitole práce prezentuje možné interpretace výsledků analýzy. Výsledky DLD skupiny ukázaly vysoké ovlivnění věkem. Vzhledem k tomu, že rozpětí věku ve skupině bylo velké, může se zde jednat o efekt vystavení jazyku. Dle Snowling (1991) je výsledek opakování pseudoslov spojen s mírou, do jaké je dítě vystaveno danému jazyku. Efekt věku u DLD skupiny může být také ovlivněn s věkem se zlepšující pracovní pamětí (Henry, 1993). Výsledky druhého modelu potvrdily poznatky předchozích studií (Archibald, 2006; Cilibrasi, 2015) ohledně obtížnosti fonologicky komplexních pseudoslov pro děti s DLD. Jak v předchozích, tak v současné studii měly děti s DLD větší problém správně zopakovat pseudoslova která obsahovala shluk souhlásek. Tato pseudoslova mohou být pro děti s DLD obtížnější, jelikož děti s DLD nemusí disponovat fonologickými reprezentacemi komplexnějších kombinací hlásek. Mohou mít také problémy s produkcí těchto pro ně neznámých fonologických sekvencí (Archibald, 2006). Skupina simultánně bilingvních mluvčích na rozdíl od DLD skupiny neukázala zhoršené opakování v 5 slabičných pseudoslovech. Tento výsledek můžeme porovnat s výsledkem Gathercole (1994). Z poznatků Gathercole (1994) vyplývá, že monolingvní děti bez řečové poruchy si vedly lépe v 5 slabičných pseudoslovech, jelikož opakování bylo usnadněno přítomností funkčních morfémů v daných slovech. Můžeme zde polemizovat, zda je tento efekt přítomen i u naší simultánně bilingvní skupiny. Výsledky sekvenčně bilingvní skupiny odhalily podobné ukazatele, jako výsledky DLD skupiny. Podobně jako DLD skupina byli mluvčí ovlivněni délkou pseudoslova ve 4 a 5 slabičných slovech. Stejně jako DLD skupina měli sekvenčně bilingvní děti větší problém správně zopakovat pseudoslova která obsahovala shluk souhlásek.

Je nutné zmínit, že vzorky dat byly relativně malé. Velikost vzorku mohla ovlivnit přesnost získaných výsledků. Dalším problémem je fakt, že skupiny byly různě velké a lišil se věk účastníků ve skupinách. Navrhuji další analýzu, při které budou zkoumány větší vzorky a jejíž skupiny budou mít stejné věkové rozpětí – tudíž bude možné statisticky porovnat všechny tři skupiny. Tato práce byla napsána v době koronavirové pandemie, která znemožnila testování větších skupin se stejným věkovým rozpětím. Další limitací výzkumu je fakt, že data byla nasbírána v minulosti pro účely jiné než analýza CNRep výsledků. Záznamové archy tedy obsahovaly pouze informaci, zda participant zopakoval slovo správně či nikoliv. Archy neobsahovaly údaje o konkrétních chybách v opakování pseudoslov (tj. v jaké části slova participant chyboval). Další studie na toto téma by se mohly zaměřit na konkrétní chyby mluvčích (tj. monolingvních dětí s DLD, simultánně bilingvních dětí, a sekvenčně bilingvních dětí). Pro analýzu konkrétních chyb navrhuji použít klasifikaci nejčastějších CNRep chyb navrženou Gathercole (1994).

V závěru práce lze dodat, že bližší analýza výsledků CNRep na základě klasifikace položek podle délky a přítomnosti shluku souhlásek může být nápomocná při diagnóze DLD pouze u simultánně bilingvních dětí. Sekvenčně bilingvní děti vykazují v těchto kategoriích podobné chování jako monolingvní děti s DLD, tudíž zde tato analýza nápomocná není. Práce tedy nepodporuje používání testu opakování pseudoslov jako jediného nástroje pro diagnózu DLD u bilingvních dětí.