

Age of Onset Effects in Child Bilingual Acquisition: Identifying the Turning Point

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ABSTRACT

This study investigates the effects of age of onset of acquisition (AO) and two other factors, chronological age of participants and language input, on sentence repetition performance. We focus on identifying the turning point for the effect of AO. Our analysis concerned sentence repetitions in German of 58 bilingual Polish-German children. The main findings were that AO and chronological age rather than cumulative input were significant predictors of correctness in the performance of bilingual children at an advanced stage of acquisition. Using receiver operating characteristic curve analysis, this paper demonstrates that the AO at 36.5 months is the optimal cut-off point to predict the general and morpho-syntactic correctness of repeated sentences. We conclude then that onset of acquisition at the age of 3 years should be identified as the boundary between first language and early child second language acquisition in the morpho-syntactic domain.

Keywords: age of onset of acquisition; chronological age; German; early second language; sentence repetition

INTRODUCTION

Previous research on language acquisition has established age of onset of acquisition (AO) (e.g., Johnson & Newport, 1989; De Keyser, 2000; Meisel, 2011; Abrahamsson & Hyltenstam, 2009; Bylund et al., 2021), chronological age of learners (e.g., Tsimpli, 2014; Schulz & Grimm, 2019), and the quality and quantity of language input (e.g., Thordardottir, 2010; Unsworth, 2013) received by them as major factors in determining the path, the rate, and the outcome of language acquisition. While their impact on language development is predictable, many questions remain about the relation between them. The present study addresses some of these questions, including the following ones. Is one of the factors a sufficient predictor of language performance? Do the factors impact on the language performance after a prolonged period of language exposure at the same level as at the initial stage? Is their impact visible in complex tasks involving grammatical reconstruction such as sentence repetition?

Many scholars have identified the age of onset of acquisition as a possible cause of differences between first (L1) and second language (L2) (e.g., Johnson & Newport, 1989; De

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Keyser, 2000; Meisel, 2011; Abrahamsson & Hyltenstam, 2009; Bylund et al., 2021), but where to set the turning point for its effect remains unclear.

This study offers an investigation of age of onset, chronological age, and cumulative input as predictors of language performance in sentence repetition in German by bilingual children. The innovative nature of our approach lies in (i) investigation of bilingual children with an understudied language pair, Polish and German, as well as (ii) using receiver operating characteristic (ROC) curve analysis for general, morpho-syntactic, lexical, and syntactic-pragmatic correctness of repeated sentences to identify the optimal threshold for the effects of the age of onset of acquisition without assuming *a priori* the cut-off point at a particular age.

THE STATE OF THE ART

THE EFFECTS OF AGE OF ONSET OF ACQUISITION

Previous research has shown that adult second language (L2) learners differ quite radically from children acquiring their first language (L1). L2 learners differ from children acquiring their L1 in the initial state of language acquisition and they have been shown to take a different developmental path and attain a different outcome (Hyltenstam & Abrahamsson, 2003). There is also a broad consensus that children simultaneously acquiring two languages from birth, or one shortly after the other, acquire them in a fashion that resembles to a great extent the monolingual acquisition of both languages (Rothweiler, 2006; Sopata, 2011; Meisel, 2011).

Many scholars explain the L1-L2 differences with reference to the effect of various age of onset of acquisition (AO) (e.g., Johnson & Newport, 1989; De Keyser, 2000; Meisel, 2011; Abrahamsson & Hyltenstam, 2009; Bylund et al., 2021). The age limit before which the onset of the acquisition must occur to ensure that the process qualifies as simultaneous language acquisition (2L1) is, however, controversial. Many scholars have proposed a number of different age ranges. According to Penfield and Roberts (1959), children are able to acquire a language directly from input until approximately nine years of age. Lenneberg (1967) claims that acquisition through mere exposure to a language disappears after puberty. McLaughlin (1978), in contrast, sets the limit at the age of three, arguing that simultaneous bilingual children are those who are exposed to both languages before that age. The issue of establishing the age range that allows for the acquisition of a language in a L1 fashion, so it may be classified as 2L1, transpired to be quite difficult in the past (see Hyltenstam & Abrahamsson, 2003; for a summary of the debate at that time) and is still under discussion.

Nicholas and Lightbown (2008) claim that L1-L2 differences may be detected at a very early age of onset; at the age of two years. Similarly, Schulz and Tracy (2011) only classify 2L1 as those children who are first exposed to the other language between birth and the age of two years. They argue that children who are exposed to the other language after the age of two years have already developed substantial lexical and grammatical knowledge in their L1. For De Houwer (2009), simultaneous bilingual children are those growing up with two languages from birth. Meisel (2008, 2011), in contrast, sets the threshold between the age of three and four years, or at around 3;6 (Meisel, 2018) basing his claim on the analysis of the acquisition path of various grammatical areas. He argues that in some aspects, i.e., inflectional morphology, the acquisition of a language exhibits similarities to L2 if its onset occurs between the ages of three and four. The same age range is also postulated by Kroffke and Rothweiler (2006), Rothweiler (2006), and

Sopata (2011) on the basis of the analysis of acquisition of various grammatical areas, such as V2, subject-verb-agreement and subordinate clauses by bilingual children.

Studies comparing sequential bilinguals with different ages of onset have shown that older children (AO 4-7 years) acquire their second language more like adult L2 (Rothweiler, 2006; Meisel, 2008; Sopata, 2011). In the case of younger children (AO 3-4 years), the similarities to L1 seem to prevail since there are the same types of error patterns in both acquisition types and the differences concern only the rate of acquisition (Prévost, 2003; Tracy & Thoma, 2008).

Previous research has shown that the age-related loss of the ability to acquire a language from mere input cannot be appropriately captured by the concept of one critical period for language acquisition, as originally claimed in the Critical Period Hypothesis (Penfields & Roberts, 1959; Lenneberg, 1967). The acquisition of different linguistic domains has been shown not to follow the same developmental path (see Eubank & Gregg, 1999). Since the loss of the ability to acquire a language is cumulative in nature and affects first one linguistic domain and then another, the critical period is better understood as a cluster of sensitive phases (Long, 1990). During such a phase the human mind is optimally prepared to integrate new information from a given subcomponent, such as syntax or morphology, into developing grammars (Meisel, 2008, 2011, 2018). In the period when the heightened sensitivity gradually fades out, language acquisition follows a developmental path characteristic of child second language acquisition (cL2) which differs from both L1 and adult L2 acquisition. The developmental path of cL2 exhibits similarities to L1 in some grammatical areas and to L2 in others (Meisel, 2008; Schwartz, 2004). A certain amount of individual variation has also been observed in cL2 (e.g., Meisel, 2018).

The reasons for and the exact nature of the differences between the various types of language acquisition are still under scrutiny. Many scholars attribute them mainly to the effect of AO and propose age-related changes in brain plasticity in the explanation of the differences (Smith & Tsimpli, 1995; Meisel, 2008, 2018), the impossibility for adults to acquire functional features in L2 (Hawkins & Franceschina, 2004), the age-related switch from predominantly implicit to explicit memory in language development (Paradis, 2003), or the transfer of L1-based processing procedures shaping adult L2 acquisition (Carroll, 2005). Children acquiring one language from birth differ, however, from older children or adults acquiring a second language in more respects than AO. Therefore, there are other factors which may determine the L1-L2 differences.

The first of these is the presence of more than one language in the brain and in the environment of a bilingual learner. The factor that distinguishes L1 from all types of bilingualism has been explored by many scholars comparing 2L1 to monolingual children. Studies have shown that 2L1 speakers do not differ generally from monolinguals. Some studies reported delays or acceleration effects, but there exists a broad consensus that the presence of another language in a learner's mind cannot be an impediment *per se* to successful 2L1 acquisition (see Meisel, 2011; for an overview). Pirvulescu et al. (2014) claim, however, that mere exposure to two languages causes the so-called bilingual effect, i.e., the different language development in bilingual children compared to L1 children, regardless of AO.

An additional factor that has to be taken into account regarding cL2 is the timing of the acquisition of a given phenomenon in L1. Tsimpli (2014) claims that syntactic phenomena acquired early in L1 may differentiate between simultaneous and (early) sequential bilinguals with an advantage for the former group. Late-acquired phenomena in L1, which involve syntax-external (e.g., semantics, pragmatics) or language-external resources (e.g., working memory), are acquired similarly by 2L1 and cL2, differentiating them from monolinguals. The modulatory influence of

timing in monolingual acquisition on AO effects has been confirmed by Schulz and Grimm (2019) for six different morpho-syntactic and semantic phenomena in L2 German.

INPUT EFFECTS

The quantity and quality of language input available to children has emerged as a competing explanation to AO for L1-L2 differences (see de Houwer, 2018; for an in-depth discussion on the many aspects of language input). Children who grow up bilingually tend to receive less input in each language than monolingual children. The claim of the reduced amount of input available to bilingual children has been challenged by de Houwer (2018). Since the amount of input may vary considerably in individual cases, she points out that the notion of reduced input for bilingual children cannot apply to all of them. Due to the huge range in variation in the language experiences of L1 children, the notion of mean input for them is statistically meaningless. Given the even higher range in variation in this respect with bilingual children, the concept of mean input may not be used as a comparison value between monolingual and bilingual children.

An accurate assessment of input quantity and quality is a very complex task related to input environment (i.e., whether the language is the majority or heritage language), parents' and children's language use, their language proficiency, etc. Finding reliable measures of input has therefore received a good deal of attention in recent research (e.g., Unsworth, 2013; Roesch & Chondrogianni, 2016). Unsworth (2013) proposed taking into account the intensity of a child's exposure to a language over time. The proposed measure of cumulative length of exposure is based on retrospective parental assessment of language use regarding the particular language. The calculation captures the sum of bilinguals' language exposure over time.

Even if the exact measure of input quantity and quality is still under discussion, many studies have shown that input can affect the rate and path of language development in a bilingual context. For instance, Thordardottir (2010) reported a relation between input quantity and developmental path for vocabulary and morpho-syntax. Restricted input has also been claimed as an explanation for a slower rate in the acquisition of certain structures because children for whom input is less available need more time to accumulate positive evidence for them (e.g., Flores et al., 2017). In some studies, however, no connection was found between the input amount at home in the majority language and children's language development (e.g., Chondrogianni & Marinis, 2011). To sum up, input quantity and quality certainly plays an important role in language development, but the input effects for language development over time, the way various language areas are affected by it, and whether input explains L1-L2 differences better than AO, thus rendering the latter superfluous, is far from established.

The AO and input factors have been also shown to interact with the chronological age of the participants and the timing of acquisition of investigated phenomena (e.g., Tsimpli, 2014). While Meisel (2018) demonstrated the AO effects for the acquisition of French gender by young children, Chondrogianni and Marinis (2011) showed the effects of input rather than AO for the acquisition of late-acquired wh-questions and passives by school-age children (mean age = 7;8). These findings support Tsimpli's hypothesis that AO effects determine the acquisition of phenomena acquired at an early age by setting the microparametric options on the one hand and on the other hand input only and no AO effects are predictive of bilingual performance related to phenomena acquired late. Schulz and Grimm (2019) extended this hypothesis showing that the late-acquired phenomena are not determined by input alone but rather also by the complexity and cross-linguistic robustness of the phenomenon acquired.

To sum up, based on previous research, three factors emerge as major possible predictors of the language performance of bilinguals: AO, the chronological age of participants due to timing of acquisition of particular phenomena, and input, the latter including the environment in which children are exposed to both languages (e.g., Qi & Di Biase, 2020).

AO AND INPUT EFFECTS IN SENTENCE REPETITION

To investigate the effects of internal and external factors on language acquisition, sentence repetition tasks (SRT) are especially useful. Sentence repetition draws upon comprehension and production processes but is different from both production and comprehension tasks (Conti-Ramsden et al., 2001; Polišenská, 2011; Makrodimitris & Schulz, 2021). The results of SRT have been found to correlate with comprehension and production results (e.g., Ruigendijk & Friedmann, 2017), but SRT involves language processing at all levels of representation in both comprehension and production (e.g., Polišenská, 2011). Successful repetition requires children to be able to decode, reconstruct, and produce the sentence based on their own grammatical knowledge (e.g., Marinis & Armon-Lotem, 2015; Polišenská et al., 2015; Makrodimitris & Schulz, 2021). Sentence repetition is, thus, conceptual in nature and involves grammatical reconstruction.

Although some studies have analysed sentence repetition in terms of memory, suggesting that it may be seen as a measure of a separate component of working memory, there is ample evidence from research to support the idea that sentence repetition reflects an underlying language competence (e.g., Chiat et al., 2013). However, this does not exclude the role of the working memory in sentence repetition. If sentences are very short, children may repeat them passively (parroting) and the results will then reflect the capacity of their working memory rather than their language abilities (e.g., Vinther, 2002).

The effects of AO have been investigated in some recent studies involving sentence repetition. The results, however, are not uniform. The important role of AO in performance on sentence repetition has been demonstrated by Meir et al. (2017), who analysed data from Russian-Hebrew children aged between 5;5 and 6;5 with varying AO of L2 Hebrew (0-60 months). The results showed the effect of AO on the features mapped differently in L1 and L2. Children with late AO (later than 48 months) committed significantly more errors in definite articles than children with an earlier AO. Chiat et al. (2013) also found a significant correlation between AO and accuracy of sentence repetition among English-Hebrew and Russian-Hebrew bilingual children aged between 4;5 and 6;11. Children with AO between 0;0 and 2;0 were found to score significantly higher than those with AO between 3;1 and 5;4. It is noteworthy that despite this AO effect, 82% of the children exposed after age 3;0 performed in the monolingual range. The two other studies by Chiat et al. (2013), however, in which Russian-German and Turkish-English children in a similar age were investigated, found no AO effects.

Sentence repetition has been also used to assess input effects on language acquisition. A recent study by de Cat (2020) demonstrated that cumulative exposure to language at school is the strongest language experience predictor of sentence repetition performance in a highly heterogeneous population of 5- to 7-year-old bilingual children in monolingual English education. Fleckstein et al. (2018) also found a significant positive effect of length of exposure and total early exposure to L2 French, defined as contact frequency before age 4, on the percentage of identical repetitions among children aged between 5;2 and 8;9.

Since the effects of AO and input are rather subtle at a more advanced stage of acquisition, we chose, as our investigation method, sentence repetition task which is sensitive to residual

language processing weaknesses that may escape detection on productive and receptive language tasks.

SOME REMARKS ON GERMAN GRAMMAR

German is a language that differs considerably in many respects from the children's other language in this study, Polish. German is a V2 language, because finite verbs are always placed in the second position in main declarative clauses (see example 1). In German subordinate clauses, the finite verb appears in the final position. Polish is a SVO language with a relatively free word order (see example 2).

(1a) *Für ihren König kämpfen die Ritter.*
for their king fight-3PL the knights-3PL
'For their king the knights fight.'

(1b) **Für ihren König die Ritter kämpfen.*
for their king the knights-3PL fight-3PL
'For their king the knights fight.'

(2a) *Dla króla walczą rycerze.*
for the king fight-3PL knights-3PL
'For their king the knights fight.'

(2b) *Dla króla rycerze walczą.*
for the king knights-3PL fight-3PL
'For their king the knights fight.'

In verb inflection, person and number markings are coded as verbal affixes in both languages. The nominal inflection in German consists of four cases (nominative, genitive, dative, accusative). German has three gender classes (masculine, feminine, and neuter), as does Polish. Both case and gender are marked in German on determiners, pronouns, and attributive adjectives. Polish is morphologically an article-less language. The nominal inflection is complex and consists of seven cases that are encoded as affixes.

German is regarded as a topic drop language. The referential null subjects and null objects are allowed in spoken German, but they are restricted to a topic position, i.e., sentence initial position (see example 3). Polish is a pro drop language (see example 4).

(3) *Kommst du mit zur Schatzinsel?*
come-2SG you along to Treasure Island?
'Will you come along to Treasure Island?'

Ø *hab ich schon gesehen* Null object
have I already seen
'I've already seen it.'

	Ø	<i>hab</i> have	<i>sie</i> it	<i>schon</i> already	<i>gesehen</i> seen	Null subject
		‘I’ve already seen it.’				
(4)	Ø	<i>Piszesz</i> write-2SG	<i>list.</i> letter			Null subject
		‘You write a letter.’				

In monolingual acquisition of German, many morphological and syntactic phenomena related to subject-verb agreement, V2 and object-verb directionality (OV/VO) are acquired early, i.e., before age 5, (Clahsen, 1982). The case marking paradigm in German is acquired very late (age 6 or later) (Tracy, 1986).

AIM AND RESEARCH QUESTIONS

Our overarching aim is to contribute to a better understanding of the role of age of onset of acquisition as one of the factors that together with other factors, such as input and chronological age, causes differences in the language performance of bilingual children. In this we focus on identifying the turning point for age of onset of acquisition, i.e., the age of onset of acquisition that distinguishes early second language acquisition from simultaneous bilingual acquisition.

Before turning to the specific research questions about the AO, it may be useful first to look at the general picture of the interplay of various factors in language acquisition. This study aims first, therefore, to investigate the effects of the three factors discussed above, i.e., age of onset of acquisition, cumulative language input, and chronological age, by assessing the performance of Polish-German bilingual children in sentence repetition task in German. The task involved different domains, such as morpho-syntactic, lexical, and syntax-pragmatic. We used a gradient measure for all three factors and incorporated them into the analysis. By measuring in degrees rather than categorical measures for the factors and not controlling for them as an inclusion criterion, we sought to treat bilingualism as a continuum. By incorporating the measures of all three factors in one analysis, we sought to disentangle the effects of the AO, cumulative input, and chronological age on bilinguals’ performance.

Our first research question is therefore as follows:

RQ1: Which of the factors, age of onset of acquisition, cumulative input, or chronological age, are significant predictors of language performance in German, as indexed in sentence repetition, by Polish-German bilingual children who differ considerably in all three factors?

Since the three factors, AO, cumulative input, and chronological age, may affect the specific language areas in different ways, we investigate their effects separately with regard to the relevant language phenomena. The second research question is therefore:

RQ2: Which of the factors are significant predictors of the performance of bilinguals in morpho-syntactic, lexical, and syntactic-pragmatic area in German separately?

Focusing on the age of onset of acquisition, the main aim of our study is to investigate a possible point that differentiates between various types of language acquisition. Bearing the previous discussion in mind, our next research question is as follows:

RQ3: What is the optimal point at which the AO best differentiates the participants with regard to the sentence repetition performance?

It has been claimed that AO affects the acquisition of morphology (e.g., Meisel, 2008; Schlyter, 2011) and syntax (e.g., Granfeldt et al., 2007; Sopata, 2011; Tsimpli, 2014). In the next step, we therefore assessed the correctness of the sentence repetition with regard to morpho-syntactic domain alone and addressed our last research question:

RQ4: What is the optimal point at which the AO best differentiates the participants with regard to the sentence repetition performance in morpho-syntactic area?

METHODOLOGY

PARTICIPANTS

Fifty-eight Polish-German bilingual children participated in the study. Polish was the L1 for all the participants and it had developed typically. In our study we focus on their other language, German, that had also developed free from any history of language disorders. The children were first exposed to German at different ages, ranging from 0;0 to 11;0. We tested 13 children with an AO from birth, 20 children with an AO from 0;2 to 3;0, 12 children with an AO from 3;1 to 6;0, and 13 children with an AO from 6;1 to 11;0.

German was the majority language, i.e., the language spoken in the environment, for all the children. Some children's parents were Polish-German couples, so German was also partially their home language. Some bilingual children's parents were Polish couples who had moved to Germany at different points in time. They used Polish at home. All children attended German schools. An overview of the participants is given in Table 1.

TABLE 1. Participant characteristics

	Bilingual children (<i>n</i> = 58)
Chronological age	<i>M</i> = 9;3 (4;11 – 13;9) <i>SD</i> = 2;6
Age of onset of acquisition of German	<i>M</i> = 3;2 (0;0 – 11;0) <i>SD</i> = 2;10
Cumulative input in German (in months)	<i>M</i> = 42.4 (12.0 – 107.6) <i>SD</i> = 25.0

A parental questionnaire was administered to gather information on background factors and in order to estimate the input children had been exposed to in both languages. In accordance with Unsworth (2013), we did not include the traditional length of exposure in years and decided to calculate cumulative input, which, like Unsworth's calculation of cumulative exposure, included information about exposure at home and outside the home and its intensity. To calculate cumulative input, we applied the following procedure: the relative amounts of input were assessed by asking parents to determine the way 100% of the input the children received could be divided between Polish and German, separately for each year of life. The experimenter always asked parents additional questions to ensure that they considered different input sources in their calculations. These questions concerned exposure to German and Polish (i) at home, including

reading, watching TV, and using the computer, (ii) at school, and (iii) outside school, including time spent with friends. Each percentage value for a one-year-period was then converted into a number of months using proportions (100% = 12 months). To calculate the cumulative input, all months of exposure to each language were added together. We thus obtained the cumulative amounts of input expressed in months that the children received from the onset of their exposure to German to the moment of testing.

MATERIAL AND PROCEDURE

We developed a sentence repetition task (SRT) targeting many aspects of grammar at the same time. The goal was to investigate children's ability to comprehend and reconstruct sentences of increasing grammatical complexity (see the sentences in Supplementary Material) independently of their ability to remember all the words exactly. We did not aim to study specific structures or features. In previous studies, we found monolingual children's performance on our SRT to converge with their performance on narrative and judgment tasks in the syntactic domain (Długosz, 2021; Sopata & Długosz, 2022).

The task comprised 30 items of varying length. All sentences were correct and involved various aspects of linguistic knowledge, including the morphological, syntactic, lexical, and syntactic-pragmatic. Most items consisted of two sentences in order to ensure that the task properly taps into the syntactic-pragmatic knowledge of the participants. The syntactic-pragmatic interface has been assessed by the use of null or overt arguments and definite or indefinite articles. Since the appropriate use of both requires the knowledge of a prior context, we developed a sentence repetition task that provides in the first sentence a short context for the second sentence containing a structure relevant to syntactic-pragmatic interface.

The items varied in length from 11 to 28 syllables. We set 11 syllables as the lower limit to avoid passive copying. It is possible, however, that younger children failed to repeat the longer sentences and older children passively copied the shorter ones. To address this concern, we conducted a logistic regression analysis with interaction between chronological age and the number of syllables as the moderating variable.

Children were given sentences orally through headphones. After the presentation of each sentence, they were asked first to perform a Stroop test in order to avoid passive echoing (parroting). The procedure was as follows: in the middle of the screen appeared a colour-word in German written in a different coloured ink, e.g., the word "pink" in green ink. The child had to read the written colour name aloud and to press the button in the colour which matched the colour name and ignore the colour of the ink. For the children aged between 4;11 and 6;0, we applied a simplified version of the Stroop test, which included two forms instead of words. In the middle of the screen appeared a square or a heart in different colours. We used two buttons: a pink heart and a blue square. The child had to press the button corresponding to the form on the screen and ignore the colour. Children received no feedback on their performance. After the Stroop test the picture of a speaking child appeared on the screen as a signal for the child to repeat the sentence. Only after the Stroop test did the child repeat the sentence.

The task began with a practice session, which consisted of three blocks. First, only the Stroop test was introduced and practiced. The children then practiced repeating the sentences. Finally, they performed a practice block consisting of both the Stroop test and sentence repetition. Before the actual task, the experimenter always asked the children if they understood the procedure

and explained it anew, if needed. All sentences were uttered by a male native speaker of German who was instructed to read them with neutral intonation in standard German.

DATA ANALYSIS

The children's repetitions were first transcribed and then assessed concerning their correctness. The assessment was conducted first generally, and then in three separate analyses concerning different aspects of linguistic knowledge: (1) morpho-syntactic correctness, (2) syntactic-pragmatic correctness, and (3) lexical correctness. All items were analysed in all three analyses. We used the 0-1 scheme which allocated a score of 1 if the child reconstructed the sentence entirely correctly. This was also the case for the repetitions that were not repeated entirely verbatim, meaning that we did not analyse the repetitions in terms of accuracy. A score of 0 was given if the child made an error regarding one of the three aspects in question in the repeated sentence or did not repeat it at all (3.3% of the data). General correctness included all grammatical and lexical errors, which were then considered separately in the other three analyses.

The phenomena assessed in the morpho-syntactic analysis included verb, noun and adjective inflection, case marking, gender assignment, and word order. Regarding verb inflection, we analysed the use of verbal affixes and past participles. Regarding noun inflection, we were concerned with the formation of plurals and use of the obligatory suffix *-(e)n* in dative plural. The analysis of adjective inflection included the use of case and gender markings. Since gender and case are also marked in determiners and pronouns, we analysed the use of articles and demonstratives as well as personal and possessive pronouns. Regarding word order, we analysed the placement of verbs, negation, and direct objects. We considered the placement of finite verbs in main and subordinate clauses, as well as the position of infinitives in complex verb structures with modals and auxiliaries used with past participles to build the perfect tense or passive voice. Prepositional phrases placed outside the complex verb structure were not classified as errors, since they may be considered acceptable in spoken German. The children received a score of 0 if they made an error in any of these areas. Example 5 presents an error in the use of gender made by one of the children.

- (5) *Was ist mit dem Flugzeug? Ich habe den repariert.*
what is with the plane? I have it-MASC repaired
'What is with the plane? I have repaired it.'

In the repeated sentence above, the child used the definite article in the masculine form instead of the target-like neuter form. As a consequence, the child received a score of 0 in this case in the morpho-syntactic analysis.

In the area of syntactic-pragmatic correctness, we analysed the use of referential subject and object pronouns. Since German null subjects and objects are restricted to the topic position, a score of 0 was given if the child produced a null subject or object in the clause-internal position.

The analysis of lexical domain included lexical substitutions, omission of words and lexical inventions which were inappropriate in the sense that they made the sentence meaningless. In such cases a score of 0 was given to the child.

Unintelligible repetitions were excluded from the data (2.0%). 1689 sentences were included in the final analysis. In sum, 446 repetitions were classified as incorrect based on the criteria presented above (26.2%).

If the child made more than one error in a sentence, a score of 0 was given only once. Each repetition was coded as 0 or 1 and was paired with the variables chronological age, age of onset, and cumulative input. Average scores per child were therefore not calculated.

Since our data were binary (0 – error/1 – no error), we used logistic regression with forward selection to investigate the association between the children’s performance on the SRT and the predictor variables chronological age, age of onset, and cumulative input. To ascertain whether this association was affected by the number of syllables, we additionally carried out logistic regression models including the number of syllables as a moderating variable. To explore further the predictive value of age of onset for the general correctness and the correctness in the morpho-syntactic domain, receiver operating characteristic (ROC) curves were made and the cut-off points with maximum sensitivities and specificities were determined. The ROC curve is a graphical method of displaying the discriminatory accuracy of a classifier for distinguishing between two populations (e.g., Fluss et al., 2005). One ROC curve power was calculated in R 3.6 using the pROC package. The analysis revealed a statistical power of 1 ($n = 1689$, $AUC = 0.6$, $\alpha = .05$).

RESULTS

LOGISTIC REGRESSION MODELS

As shown in Table 2, although all four models fitted the data well, the explained variance was low. Chronological age and age of onset emerged as significant predictors of all correctness measures. Age of onset was negatively associated with all correctness measures, meaning that with increasing age of onset, the correctness decreased ($OR < 0.96; 0.98 >$). As age of onset increased by one month, the likelihood of correct responses decreased by 4% for the general correctness ($OR = 0.96$), by 3% for the morpho-syntactic correctness ($OR = 0.97$), by 2% for the lexical correctness ($OR = 0.98$), and by 3% for the syntactic-pragmatic correctness ($OR = 0.97$).

Chronological age was also positively associated with all correctness measures, with older children scoring higher across the board ($OR < 1.04; 1.06 >$). As chronological age increased by one month, the likelihood of correct responses increased by 6% for the general correctness ($OR = 1.06$), by 5% for the morpho-syntactic correctness ($OR = 1.05$), by 4% for the lexical correctness ($OR = 1.04$), and by 4% for the syntactic-pragmatic correctness ($OR = 1.04$).

Cumulative input was found not to predict any of the correctness measures.

TABLE 2. *The summary of logistic regression models*

	<i>B</i>	<i>SE</i>	<i>p</i>	<i>OR</i>	95% CI for OR
General Correctness					
Chronological age	0,06	0,01	<0,001	1,06	[1,04; 1,07]
Age of onset	-0,04	0,01	<0,001	0,96	[0,95; 0,97]
Cumulative input	0,01	0,01	0,390	1,01	0,99; 1,03]
Constant	-3,27	0,32	<0,001	0,04	
Cox-Snell $R^2 = 0,241$					
Morpho-syntactic Correctness					
Chronological age	0,05	0,01	<0,001	1,05	[1,03; 1,07]
Age of onset	-0,04	0,01	<0,001	0,97	[0,95; 0,98]
Cumulative input	0,02	0,01	0,091	1,02	[0,99; 1,05]
Constant	-2,63	0,35	<0,001	0,07	
Cox-Snell $R^2 = 0,189$					
Lexical Correctness					

Chronological age	0,04	0,01	0,002	1,04	[1,01; 1,07]
Age of onset	-0,03	0,01	0,020	0,98	[0,96; 0,99]
Cumulative input	0,01	0,02	0,578	1,01	[0,97; 1,05]
Constant	-0,54	0,47	0,246	0,58	
Cox-Snell R ² = 0,051					
Syntactic-pragmatic Correctness					
Chronological age	0,04	0,02	0,015	1,04	[1,01; 1,08]
Age of onset	-0,03	0,02	0,044	0,97	[0,94; 0,99]
Cumulative input	-0,01	0,02	0,725	0,99	[0,94; 1,04]
Constant	0,57	0,63	0,367	1,77	
Cox-Snell R ² = 0,021					

To address the concern that testing at an early age may constrain the capacity to repeat long sentences and that a greater chronological age may lead to passive copying of longer sentences, we included the number of syllables as a moderating variable in logistic regression models. The models showed that the number of syllables was negatively associated with general, morpho-syntactic, and lexical correctness, with higher correctness scores on shorter sentences and by analogy with lower correctness scores on longer sentences. The number of syllables was found, however, not to moderate the association between chronological age and correctness, meaning that with increasing chronological age the performance at all levels increased irrespective of the length of sentences. Detailed results of the regression models are included in Appendix A.

Finally, we conducted logistic regression to determine whether the number of syllables moderated the association between age of onset and correctness. The number of syllables was found not to moderate the association between age of onset and correctness, meaning that with increasing age of onset the performance at all levels decreased irrespective of the length of sentences. Detailed results of the regression models are included in Appendix B.

Since cumulative input was not predictive of correctness, we ran no logistic regression with the number of syllables as the moderating variable in this case.

RECEIVER OPERATING CHARACTERISTIC (ROC) CURVE ANALYSIS

To explore further the predictive value of age of onset for correctness, receiver operating characteristic (ROC) curves were made, and the cut-off points were set. Committing errors (General Correctness) was set as the state variable. The AUC (area under the curve) for general correctness was equal to 0.67 ($SE = 0.01$; $p < .002$; 95% CI 0.64–0.70), indicating that age of onset was an acceptable indicator of general correctness and could distinguish between two groups (Fawcett, 2006). The Gini Index, a measure of inequality, was 0.33, thus indicating that the model fitted the data well. We used the Kolmogorov-Smirnov test to select the optimal cut-off point, which corresponded with the point on the ROC curve which was maximally distant from the reference line. The K-S statistics yielded 36.5 months as the optimal cut-off point, giving a sensitivity of 0.635 and a 1-specificity of 0.349. The Youden Index revealed the same cut-off point (YI = 0.286). The model had high precision of prediction (0.833). The ROC curve is shown in Figure 1.

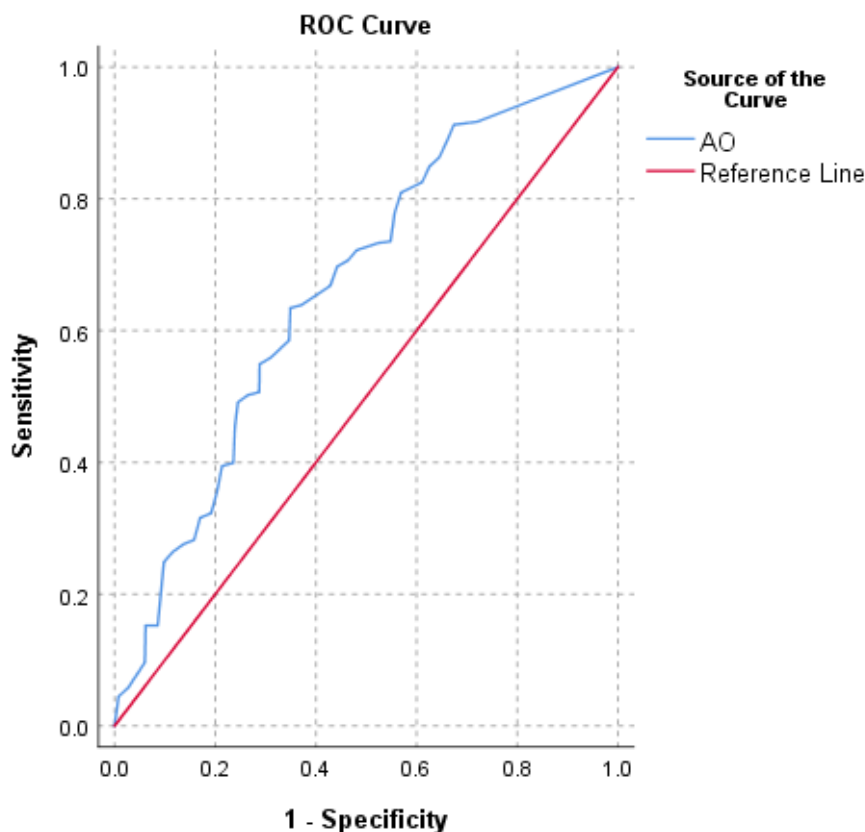


FIGURE 1. The ROC curve for general correctness

The ROC curve was also made for the correctness in the morpho-syntactic domain. The AUC was 0.66, indicating that the classifier was not random, although the Gini Index provided a moderate fit to the data (0.328). The cut-off point for the morpho-syntactic correctness was the same as for the general correctness, i.e., 36.5 months. Detailed results are included in Table 3.

TABLE 3. The summary of the ROC curve analysis for morpho-syntactic correctness

	<i>AUC</i>	<i>SE</i>	<i>p</i>	<i>LL</i>	<i>UL</i>	<i>Gini index</i>	<i>Max K-S (Youden Index)</i>	<i>Cut-off point</i>	<i>Sensitivity</i>	<i>1-Specificity</i>
Morpho-syntactic Correctness	0,66	0,02	<0,001	0,63	0,70	0,328	0,297	36,5	0,660	0,363

Regarding general correctness, the children with an AO \leq 36.5 months scored 83.3%, whereas the children with an AO $>$ 36.5 months scored 60.6% ($p < .001$; $\phi = 0.25$). The same cut-off point was determined for the morpho-syntactic correctness, with the children with an AO \leq 36.5 months scoring 89.2% and the children with an AO $>$ 36.5 months scoring 70.7% ($p < .001$; $\phi = 0.23$). In the lexical domain, the difference between the children with an AO \leq 36.5 months (95.5%) and those with an AO $>$ 36.5 months (91.2%) was much smaller, so was the effect size ($p < .001$; $\phi = 0.09$). Concerning the syntactic-pragmatic area, the difference between the children

with an AO \leq 36.5 months (97.8%) and those with an AO $>$ 36.5 months (95.6%) was even smaller, and the effect size was weaker ($p = .012$; $\phi = 0.06$). Detailed results are presented in Table 4.

TABLE 4. The results of comparisons between the groups determined by the cut-off point of 36.5 months

	AO \leq 36,5		AO $>$ 36,5		χ^2	p	ϕ
	n	%	n	%			
General Correctness	811	83,3	435	60,6	109,52	<0,001	0,25
Morpho-syntactic Correctness	849	89,2	483	70,7	89,79	<0,001	0,23
Lexical Correctness	909	95,5	623	91,2	12,27	<0,001	0,09
Syntactic-pragmatic Correctness	931	97,8	653	95,6	6,29	0,012	0,06

DISCUSSION

The data analysis in the previous section answers the four research questions that guided our study. As regards the first research question, concerning the effects of all three factors, i.e., age of onset of acquisition, cumulative input, and chronological age, on language performance of bilingual children in sentence repetition task, the results of our study show that two of them, AO and chronological age, are significant predictors of correctness in the performance of bilingual children in German. Empirically identifying the L1-L2 turning point for AO is the main goal of this study and we shall return to this point later in the discussion. AO of German in the case of the participants of this study ranged from 0 to 11 years with the mean AO at 3;2 years (see Table 1). Analysis has revealed that for each month the AO is increased the chances for general correctness decreased by 4% (OR = 0.96, see Table 2). The study thus shows that a later onset of acquisition affects language performance in a negative way even after relatively long exposure to the language, as evidenced by the mean value of cumulative input to German at 42 months. The analysis of moderation has also revealed that the length of sentences did not moderate the correlation between AO and the correctness of sentences repeated, and thus the analysis has ensured that the results demonstrating the effect of AO on language performance are not confounded with such factors as age related increase of working memory capacity.

Similar to AO, the chronological age of children transpired to be another significant predictor of sentence repetition performance. The group differed in this respect from 4;11 to 13;9 years, with the mean at 9;3 years (see Table 1). The regression analysis revealed that the likelihood of higher general correctness increased with increasing chronological age (OR = 1.06, see Table 2). Unexpectedly, the cumulative language input did not predict correctness in sentence repetition. This finding may be explained by the relatively advanced stage of acquisition of our participants. The cumulative input ranges in the group from 12.0 to 107.6 months, with the mean at 42.4 months. At this stage of acquisition, the sheer amount of cumulative input turns out not to be a significant predictor for language performance.

The fact that the cumulative language input has been shown not to be a significant predictor and the chronological age has, suggests that, although the language performance at the more advanced stage is unaffected by the sheer amount of cumulative input in the past, it is affected by the age at which the participants are tested. The reasons for the effect of chronological age of participants on language performance may be twofold, since chronological age is undoubtedly related to the amount of input children have received and it is also connected with the age-related changes in cognitive skills and working memory of children. The analysis of moderation has

revealed, however, that the length of sentences did not moderate the correlation between the chronological age and the correctness of sentence repetition. This suggests that chronological age is not one of the significant predictors of correctness due to the increase in children's working memory capacity.

In accordance with Schulz and Grimm (2019), we argue that chronological age of the participants determines whether we might expect bilingual children to have sufficient time to acquire more complex phenomena by the age of testing and to catch up in their acquisition with their monolingual peers. The effects of chronological age are related to the timing in which different phenomena are acquired in L1 (Tsimpli, 2014). Structures that are more complex and require a greater critical mass of input are usually acquired later in L1. Older bilingual children even with possibly less input in their other language are more advanced in their L1 acquisition. They have therefore arguably more opportunity to catch up in the acquisition of more complex phenomena in their other language than younger children with less advanced L1 acquisition. The chronological age, together with timing, therefore plays a different role than cumulative input, depending on whether the phenomena being tested are acquired early or late (see Armon-Lotem et al., 2021). The sentence repetition in this study involved a wide range of linguistic constructs, including complex structures. In addition to AO the chronological age rather than the cumulative input thus transpired to be a significant predictor of sentence repetition performance of the participants.

Taking into account that the effects of the three factors, i.e., AO, cumulative input, and chronological age, may differ in the specific language areas, we analysed their effects separately in regard to the relevant phenomena. In respect to the second research question of our study concerning the effects of the three factors in morpho-syntactic, lexical, and syntactic-pragmatic areas, the analysis revealed that assessing the three areas separately yielded similar results as in the joint analysis. In all the three domains, the significant predictors turned out to be AO and chronological age. An increase in chronological age of one month increases the chances for correctness in morpho-syntactic, lexical, and syntactic-pragmatic areas by 5% or 4% (see Table 2). An increase in AO by one month reduces the chances for correctness in morpho-syntactic, lexical, and syntactic-pragmatic areas by 3% or 2% (see Table 2). While assessing morpho-syntactic, lexical, and syntactic-pragmatic domains separately, cumulative input was also revealed not to be a significant predictor for correctly repeated sentences. This finding may be explained by the participants' relatively advanced stage of language acquisition, at which the amount of input plays no determining role.

The findings showing AO to be a significant predictor of language performance are in line with studies demonstrating the impact of AO (e.g., De Keyser, 2000; Abrahamsson & Hyltenstam, 2009; Meisel, 2018, Bylund et al., 2021; to name but a few). Chronological age has also been demonstrated to be an important factor for the achievement of language proficiency in previous research (e.g., Armon-Lotem et al., 2021). The results of present study lend additional support to these claims.

The logistic regression models fitted the data well, yet they explained only a part of the variance in the data, which suggests the conclusion that AO and chronological age are not the only factors determining language performance and that they interact with a multiplicity of other factors.

One important finding of this study is the confirmation of the effects of AO in the sentence repetition performed by bilingual children who have been acquiring their other language for some years. In this respect our findings are, therefore, in line with the studies of Meir et al. (2017) and

partially so with Chiat et al. (2013) who also found the AO effects in sentence repetition in early child L2. The task of sentence repetition has been shown to be a reliable tool for tracing subtle differences between language performance of bilingual children who began acquisition of their other language at different ages.

The results also show that AO affects language performance even after a prolonged period of acquisition. Considering the mean length of cumulative input of the participants was 42.4 months, the results of this study support the claim for lasting effects of AO.

The sentence repetition task used in this study targeted a variety of structures and the repeated sentences were analysed in respect to morpho-syntactic, lexical, and syntactic-pragmatic correctness. Many morpho-syntactic features are mapped differently in the two languages in question, i.e., Polish and German. The phenomena at the syntactic-pragmatic interface are also different in both languages; Polish being a pro-drop language and German a topic-drop language. The effect of AO may, therefore, be related to the cross-linguistic influence that previous studies have shown affect more bilinguals with a later AO (Sopata, 2011, 2021). Since we did not analyse the phenomena which are similar and different in L1 vs. L2 separately, however, on the basis of the results of this study we are unable to tease apart the possible effects of cross-linguistic influence from other factors influencing the L2 development.

Having established that AO is a significant predictor of language performance during sentence repetition, we may now turn to the main aim of the article, i.e., identifying the optimal point at which the AO best differentiates the participants with regard to the correctness of repeated sentences, thus answering our third research question. Both the Youden Index and the ROC analysis reveal that the optimal point that divides the participants into two groups with most different scores with regard to general correctness in sentence repetition was the age of 36.5 months. The model had a high precision value. The group with AO below this cut-off point repeated the sentences with the general correctness of 83.3%, whereas those children with an AO above 36.5 months repeated the sentences with the general correctness of 60.6%.

The threshold of 36.5 months also clearly distinguishes the performance of the participants in the specific linguistic areas. For the morpho-syntactic area the difference between the participants below and above the cut-off point of 36.5 months is substantial (89.2% vs. 70.7%; $p < 0.001$, $\phi = 0.25$). The difference in lexical domain (95.5% vs. 91.2%; $p < 0.001$, $\phi = 0.09$) and at the syntactic-pragmatic interface (97.8% vs. 95.6%; $p < 0.012$, $\phi = 0.06$) is less prominent than it is in the case of morpho-syntactic area, but even in these areas the difference is statistically significant. These results demonstrate then that the age of 3 years, and precisely 36.5 months, is indeed an important turning point regarding the age of onset of acquisition. Even after several years of language exposure, the sentence repetition performance of the participants differs regarding general correctness depending on the AO before or after the age of 3 years.

The debate on the effects on AO tends to concern the areas of grammar that include inflectional morphology and syntax. The fourth research question addressed the optimal point at which the AO best differentiated the participants with regard to the sentence repetition performance on the basis of the morpho-syntactic area alone. The analysis of the repeated sentences with regard to children's performance in morpho-syntactic aspects yielded a similar result as the analysis of the general correctness of repeated sentences. The optimal cut-off point that best distinguished the participants into two groups with most different scores for correctness in the morpho-syntactic area was the age of 36.5 months, just as in the case of general correctness.

The study then yields novel evidence based on the ROC curve analysis of sentence repetitions that the turning point for the effect of age of onset of acquisition should be identified

around the age of 3 years. Since language acquisition is a process that has been shown in past research to be subject to individual variation, we do not argue that this threshold applies to every individual beginning to acquire a language sometime after birth. We also agree with Luk (2015) and de Cat (2020) that bilingualism is best treated as continuum. In the face of clear differences between simultaneous and sequential bilingualism, however, the cut-off point has to be set. The findings of this study demonstrate that the optimal turning point for the effect of the age of onset of acquisition should be set around the age of 3 years.

The evidence complements such studies that propose a similar turning point for AO effects based on the investigations into the developmental paths for second languages concentrating on qualitative or quantitative L1-L2 differences (see Meisel, 2018; for a summary). The empirical evidence from this study also lends indirect support to claims regarding less than native-like attainment in childhood L2 acquisition due to later AO (e.g., Abrahamsson & Hyltenstam, 2009; Bylund et al., 2021). The differences between the groups with an AO below and above 3 years which are detectable in sentence repetition task after approximately 42.4 months of cumulative input in German show that the bilingual children are well on the way to achieving a variety of acquisition outcomes in German depending on AO differences.

The negative effect of an AO later than 3 years on sentence repetition is most prominent in the area of morpho-syntax. This is an expected outcome since the age-related changes underlying the L1-L2 differences first of all affect the formal aspects of language. The majority of morpho-syntactic properties in German, excluding case marking, are acquired early in monolingual acquisition and thus the negative effect of a later AO is very clear. The phenomena at the syntax-pragmatic interface, i.e., phenomena related to pragmatically conditioned aspects of argument realisation, are acquired later in monolingual acquisition and the effect of a later AO is therefore much less prominent. The findings are therefore in line with the timing hypothesis of Tsimpli (2014), who predicts that AO effects determine the acquisition of phenomena acquired at an early age.

Our findings do not permit us to say whether the heightened sensitivity of the human mind to integrate new information from particular domains into developing grammars begins to fade out earlier than the age of 36.5 months, i.e., the age in question. It is logically possible that the heightened sensitivity of specific areas, characteristic of the sensitive phases, began to ebb earlier than at the age of 36.5 months, and at this point the accumulation of changes in the mind lead to the diminished correctness of bilingual children who began the acquisition of their other language above this cut-off point. A heightened sensitivity may alternatively begin to fade around the age of 3 years, but the process is so fast that it results in lower correctness scores for sentence repetition performance among bilingual children who began acquisition of their other language later than at the age of 36.5 months. The results of this study have shown that the threshold of 36.5 months for AO best distinguishes the abilities of children regarding sentence repetition and it therefore seems reasonable to assume that the weakening of the heightened sensitivity for new information from the majority of particular domains begins not later than this age.

The study shows that bilinguals with AO below the cut-off point of 3 years perform at a similar level as those who began acquisition of both languages from birth. They are at least more similar to them than to bilinguals with later AO. Even if the bilinguals with AO ranging from 0 to 3 years may differ in some respects, this study therefore shows that they should be treated as one group of simultaneous bilinguals as opposed to a group of early child second language learners with AO above 3 years.

To conclude, our findings indicate that the age of onset of acquisition and chronological age are significant predictors of performance in sentence repetition in German of Polish-German bilingual children. Considering the relatively high mean length of cumulative input in German received by children in this study, the findings lend support for the claim for the lasting effects of AO. Using an ROC curve analysis, the findings provide novel evidence for identifying the cut-off point for early child second language acquisition at the age of around three years. Based on our findings, bilingual children who begin to acquire their other language before the age of 3 years should be classified as simultaneous bilinguals and those who begin to acquire it later as early child L2 learners.

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REFERENCES

- Abrahamsson, N. (2012). Age of onset and nativelike L2 ultimate attainment of morphosyntactic and phonetic intuition. *Studies in Second Language Acquisition*, 34, 187-214.
- Abrahamsson, N., & Hyltenstam, K. (2009). Age of onset and nativelikeness in a second language: Listener perception versus linguistic scrutiny. *Language Learning*, 59, 249-306.
- Armon-Lotem, S., Rose, K., & Altman, C. (2021). The development of English as a heritage language: The role of chronological age and age of onset of bilingualism. *First language*, 41, 67-89.
- Bylund, E., Hyltenstam, K., Abrahamsson, N. (2021). Age of acquisition – not bilingualism – is the primary determinant of less than nativelike L2 ultimate attainment. *Bilingualism: Language and Cognition*, 24, 18-30.
- Carroll, S. (2005). Input and SLA: Adults' sensitivity to different sorts of cues to French gender. *Language Learning*, 55, 79-138.
- Chiat, S., Armon-Lotem, S., Marinis, T., Polišenská, K., Roy, P., & Seeff-Gabriel, B. (2013). The potential of sentence imitation tasks for assessment of language abilities in sequential bilingual children. In V. C. M. Gathercole (Ed.), *Issues in the assessment of bilinguals* (pp. 56-89). Bristol: Multilingual Matters.
- Chondrogianni, V., & Marinis, T. (2011). Differential effects of internal and external factors on the development of vocabulary, tense morphology and morpho-syntax in successive bilingual children. *Linguistic Approaches to Bilingualism*, 1, 318-345.
- Clahsen, H. (1982). *Spracherwerb in der Kindheit*. Tübingen: Narr.
- Conti-Ramsden, G., & Botting, N. (2001). Psycholinguistic markers for specific language impairment (SLI). *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 42, 741-748.
- De Cat, C. (2020). Predicting language proficiency in bilingual children. *Studies in Second Language Acquisition*, 42, 279-325.
- De Houwer, A. (2009). *Bilingual first language acquisition*. Bristol: Multilingual Matters.
- De Houwer, A. (2018). The role of language input environments for language outcomes and language acquisition in young bilingual children. In D. Miller, F. Bayram, J. Rothman, &

- L. Serratrice (Eds), *Bilingual cognition and language: The state of the science across its subfields* (pp. 127-154). Amsterdam: John Benjamins.
- De Keyser, R. M. (2000). The robustness of critical period effects in second language acquisition. *Studies in Second Language Acquisition*. 22, 493-533.
- Długosz, K. (2021). *Der Altersfaktor beim fortgeschrittenen Zweitspracherwerb: Die Wortstellung im Deutschen bei polnisch-deutsch bilingualen Kindern*. Tübingen: Narr.
- Eubank, L., & Gregg, K. R. (1999). Critical periods and (second) language acquisition: Divide et impera. In D. Birdsong (Ed.), *Second language acquisition and the Critical Period Hypothesis* (pp. 65-99). Mahwah, New Jersey: Lawrence Erlbaum.
- Fawcett, T. (2006). An introduction to ROC analysis. *Pattern Recognition Letters*. 27, 861-874.
- Fleckstein, A., Prévost, P., Tuller, L., Sizaret, E., & Zebib, R. (2018). How to identify SLI in bilingual children: A study on sentence repetition in French. *Language Acquisition*. 25, 85-101.
- Flores, C., Santos, A. L., Jesus, A., & Marques, R. (2017). Age and input effects in the acquisition of mood in Heritage Portuguese. *Journal of Child Language*. 44, 795-828.
- Fluss, R., Faraggi, D., & Reiser, B. (2005). Estimation of the Youden Index and its associated cutoff point. *Biometrical Journal*. 47, 458-472.
- Granfeldt, J., Schlyter, S., & Kihlstedt, M. (2007). French as cL2, 2L1 and L1 in pre-school children. In J. Granfeldt (Ed.), *Studies in Romance bilingual acquisition – Age of onset and development of French and Spanish* (pp. 7-42). Lund: Centre for Languages and Literature.
- Hawkins, R., & Franceschina, F. (2004). Explaining the acquisition and non-acquisition of determiner-noun gender concord in French and Spanish. In P. Prévost & J. Paradis (Eds.), *The acquisition of French in different contexts: Focus on functional categories* (pp. 175-205). Amsterdam: John Benjamins.
- Hyltenstam, K., & Abrahamsson, N. (2003). Maturation constraints in second language acquisition. In C. J. Doughty & M. H. Long (Eds.), *Handbook of second language acquisition* (pp. 539-588). Oxford: Blackwell.
- Johnson, J., & Newport, E. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology*. 21, 60-90.
- Kroffke, S., & Rothweiler, M. (2006). Variation im frühen Zweitspracherwerb des Deutschen durch Kinder mit türkischer Erstsprache. In M. Vliegen (Ed.), *Variation in Sprachtheorie und Spracherwerb. Akten des 39. Linguistischen Kolloquiums in Amsterdam* (pp. 145-154). Frankfurt am Main: Peter Lang.
- Lenneberg, E. H. (1967). *Biological foundations of language*. New York: Wiley.
- Long, M. H. (1990). Maturation constraints on language development. *Studies in Second Language Acquisition*. 12, 251-285.
- Luk, G. (2015). Who are the bilinguals (and monolinguals)? *Bilingualism: Language and Cognition*. 18, 35-36.
- Makrodimitris, C., & Schulz, P. (2021). Does timing in acquisition modulate heritage children's language abilities? Evidence from the Greek LITMUS Sentence Repetition Task. *Languages*. 6, 1-17.
- Marinis, T., & Armon-Lotem, S. (2015). Sentence repetition. In S. Armon-Lotem, J. de Jong, & N. Meir (Eds.), *Assessing multilingual children. Disentangling bilingualism from language impairment* (pp. 95-121). Bristol: Multilingual Matters.
- McLaughlin, B. (1978). *Second language acquisition in childhood*. Hillsdale, NJ: Erlbaum.

- Meir, N., Walters, J., & Armon-Lotem, S. (2017). Bi-directional cross-linguistic influence in bilingual Russian-Hebrew children. *Linguistic Approaches to Bilingualism*, 7, 514-553.
- Meisel, J. M. (2018). Early child second language acquisition: French gender in German children. *Bilingualism: Language and Cognition*, 21, 656-673
- Meisel, J. M. (2008). Child second language acquisition or successive first language acquisition? In B. Haznedar & E. Gavrusseva (Eds.), *Current trends in child second language acquisition: A generative perspective* (pp. 55-80). Amsterdam: John Benjamins.
- Meisel, J. M. (2011). *First and second language acquisition: Parallels and differences*. Cambridge: Cambridge University Press.
- Nicholas, H., & Lightbown, P. M. (2008). Defining child second language acquisition, defining roles for L2 instruction. In J. Philp, R. Oliver, & A. Mackey (Eds), *Second language acquisition and the younger learner. Child's play?* (pp. 27-52). Amsterdam: John Benjamins.
- Paradis, M. (2003). Differential use of cerebral mechanisms in bilinguals. In M. T. Banich & M. Mack (Eds.), *Mind, brain, and language: Multidisciplinary perspectives* (pp. 351-370). New York: Routledge.
- Penfield, W., & Roberts, L. (1959). *Speech and brain mechanisms*. Princeton: Princeton University Press.
- Pirvulescu, M., Pérez-Leroux, A. T., Roberge, Y., Strik, N., & Thomas, D. (2014). Bilingual effects: Exploring object omission in pronominal languages. *Bilingualism: Language and Cognition*, 17, 495-510.
- Polišenská, K. (2011). *The influence of linguistic structure on memory span: Repetition tasks as a measure of language ability*. Unpublished Ph.D. thesis, City University London.
- Polišenská, K., Chiat, S., & Roy, P. (2015). Sentence repetition: what does the task measure? *International Journal of Language and Communication Disorders*, 50, 106-118.
- Prévost, P. (2003). Truncation and missing inflection in initial child L2 German. *Studies in Second Language Acquisition*, 25, 65-97.
- Qi, R., & Di Biase, B. (2020). The influence of the environmental language (L_E) in Mandarin-English bilingual development: The case of transfer in *wh*-questions. *International Journal of Bilingualism*, 24, 691-714.
- Roesch, A. D., & Chondrogianni, V. (2016). "Which mouse kissed the frog?" Effects of age of onset, length of exposure, and knowledge of case marking on the comprehension of *wh*-questions in German-speaking simultaneous and early sequential bilingual children. *Journal of Child Language*, 43, 635-661.
- Rothweiler, M. (2006). The acquisition of V2 and subordinate clauses in early successive acquisition of German. In C. Lleó (Ed.), *Interfaces in multilingualism* (pp. 91-113). Amsterdam: John Benjamins.
- Ruigendijk, E., & Friedmann, N. (2017). A Deficit in movement-derived sentences in German-speaking hearing-impaired children. *Frontiers in Psychology*, 8, 1-22.
- Schlyter, S. (2011). Tense and aspect in early French development in aL2, 2L1 and cL2 learners. In E. Rinke & T. Kupisch (Eds.), *The development of grammar: Language acquisition and diachronic change* (pp. 47-74). Amsterdam: John Benjamins.
- Schulz, P., & Grimm, A. (2019) The age factor revisited: Timing in acquisition interacts with age of onset in bilingual acquisition. *Frontiers in Psychology*, 9, 1-18.
- Schulz, P., & Tracy, R. (2011). *LiSe-DaZ - Linguistische Sprachstandserhebung Deutsch als Zweitsprache*. Göttingen: Hogrefe.

- Schwartz, B. D. (2004). On child L2 development of syntax and morphology. *Lingue e Linguaggio*. 3, 97-132.
- Smith, N., & Tsimpli, I.-M. (1995). *The mind of a savant: Language learning and modularity*. Oxford: Basil Blackwell.
- Sopata, A. (2011). Placement of infinitives in successive child language acquisition. In E. Rinke & T. Kupisch (Eds.), *The development of grammar: Language acquisition and diachronic change* (pp. 105-121). Amsterdam: John Benjamins.
- Sopata, A. (2021). Cross-linguistic influence in the development of null arguments in early successive bilingual acquisition. *Linguistic Approaches to Bilingualism*. 11, 192-221.
- Sopata, A., & Długosz, K. (2022). The effects of language input on word order in German as a heritage and majority language. *Language Acquisition*. 29, 198-228.
- Thordardottir, E. (2010). The relationship between bilingual exposure and vocabulary development. *International Journal of Bilingualism*. 15, 426-445.
- Tracy, R. (1986). The acquisition of case morphology in German. *Linguistics*. 24, 47-78.
- Tracy, R., & Thoma, D. (2008). Convergence on finite V2 clauses in L1, bilingual L1 and early L2 acquisition. In P. Jordens & C. Dimroth (Eds.), *Functional elements: Variation in learner systems*. Berlin: Mouton de Gruyter.
- Tsimpli, I.-M. (2014). Early, late or very late? *Linguistic Approaches to Bilingualism*. 4, 283-313.
- Unsworth, S. (2013). Assessing the role of current and cumulative exposure in simultaneous bilingual acquisition: The case of Dutch gender. *Bilingualism: Language and Cognition*. 16, 86-110.
- Vinther, T. (2002). Elicited imitation: A brief overview. *International Journal of Applied Linguistics*. 12, 54-73.

APPENDIX A

The summary of logistic regression models for chronological age with the number of syllables as a moderating variable

	<i>B</i>	<i>SE</i>	<i>Z</i>	<i>p</i>	95% CI
General Correctness					
Chronological age	0,02	0,01	10,30	<0,001	[0,02; 0,03]
No. of syllables	-0,09	0,01	-6,09	<0,001	[-0,11; -0,06]
Chronological age x No. of syllables	<0,01	<0,01	0,82	0,412	[-0,01; 0,01]
Constant	1,15	0,06	18,66	<0,001	[1,03; 1,27]
Cox-Snell R ² = 0,093					
Morpho-syntactic Correctness					
Chronological age	0,02	0,01	8,78	<0,001	[0,02; 0,03]
No. of syllables	-0,11	0,02	-6,04	<0,001	[-0,13; -0,07]
Chronological age x No. of syllables	<0,01	<0,01	0,68	0,496	[-0,01; 0,01]
Constant	1,66	0,07	22,30	<0,001	[1,52; 1,81]
Cox-Snell R ² = 0,081					
Lexical Correctness					
Chronological age	0,02	0,01	5,39	<0,001	[0,01; 0,03]
No. of syllables	-0,08	0,03	-3,01	0,003	[-0,1; -0,03]
Chronological age x No. of syllables	<0,01	<0,01	0,42	0,674	[-0,01; 0,01]
Constant	2,93	0,12	23,42	<0,001	[2,69; 3,18]
Cox-Snell R ² = 0,030					
Syntactic-pragmatic Correctness					
Chronological age	0,02	0,01	3,68	<0,001	[0,01; 0,03]
No. of syllables	-0,04	0,04	-1,15	0,250	[-0,12; 0,03]
Chronological age x No. of syllables	<-0,01	<0,01	-0,57	0,568	[-0,01; 0,01]
Constant	3,60	0,17	21,56	<0,001	[3,28; 3,93]
Cox-Snell R ² = 0,010					

APPENDIX B

The summary of logistic regression models for age of onset with the number of syllables as a moderating variable

	<i>B</i>	<i>SE</i>	<i>Z</i>	<i>p</i>	95% CI
General Correctness					
AO	-0,02	0,01	-9,98	<0,001	[-0,02; -0,01]
No. of syllables	-0,09	0,01	-6,50	<0,001	[-0,12; -0,06]
AO x No. of syllables	<0,01	<0,01	0,61	0,542	[-0,01; 0,01]
Constant	1,13	0,06	18,70	<0,001	[1,01; 1,25]
Cox-Snell R ² = 0,082					
Morpho-syntactic Correctness					
AO	-0,02	0,01	-8,39	<0,001	[-0,02; -0,01]
No. of syllables	-0,11	0,02	-6,66	<0,001	[-0,14; -0,07]
AO x No. of syllables	<0,01	<0,01	1,16	0,248	[-0,01; 0,01]
Constant	1,63	0,07	22,55	<0,001	[1,49; 1,77]
Cox-Snell R ² = 0,003					
Lexical Correctness					
AO	-0,01	0,01	-3,24	0,001	[-0,01; -0,01]
No. of syllables	-0,09	0,02	-3,73	<0,001	[-0,14; -0,04]
AO x No. of syllables	<0,01	<0,01	0,89	0,371	[-0,01; 0,01]
Constant	2,81	0,11	24,94	<0,001	[2,59; 3,03]
Cox-Snell R ² = 0,014					
Syntactic-pragmatic Correctness					
AO	-0,01	0,01	-1,93	0,053	[-0,01; 0,01]
No. of syllables	-0,03	0,03	-0,83	0,404	[-0,09; 0,04]
AO x No. of syllables	<-0,01	<0,01	-0,37	0,710	[-0,01; 0,01]
Constant	3,48	0,15	23,55	<0,001	[3,19; 3,77]
Cox-Snell R ² = 0,003					

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