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Keeping two languages apart: Connective processing in both languages of Russian–German bilinguals

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Abstract

Multilingual children are faced with the task of selectively using the linguistic systems of their languages. Previous research has shown that although bilinguals may make more errors in production and comprehension than their monolingual peers, less cognitively demanding processing experiments may reveal target-like performance. This has been attributed to several factors, among which language transfer and processing limitations. In this study we investigate the processing of additive connectives in both languages of German–Russian bilingual children using the Visual World Paradigm. Previous research has shown that bilingual children make many errors in the production of these connectives in Russian. The results show that the processing behaviour in both languages of the bilingual children does not differ from that of their monolingual peers. This finding is compatible with the view that errors in production and in more demanding comprehension tasks are due to processing limitations.

Introduction

It is well-established that bilingual children differentiate their languages from early on. Their development in each language largely resembles that of monolinguals (e.g., De Houwer, 1990; Genesee, Nicoladis & Paradis, 1995). However, bilingual development may differ from monolingual acquisition in several respects. To begin with, it may take bilinguals longer to acquire certain linguistic phenomena, especially frequency-sensitive phenomena such as vocabulary (Bialystok, Luk, Peets & Yang, 2010; Foursha-Stevenson & Nicoladis, 2011) and grammatical gender (Janssen, 2016; Nicoladis & Marchak, 2011; Rodina & Westergaard, 2017). At the same time, acquisition can be facilitated, if the category in question is more salient and transparent in the other language of a bilingual (Gawlitzek-Maiwald & Tracy, 1996). For example, Dutch children who also speak Limburgian (a typologically related language with a more salient gender system than Dutch) acquire the opaque system of Dutch grammatical gender faster than Dutch monolingual children, which is seen as evidence of positive transfer from Limburgian, (Cornips & Hulk, 2006). Finally, bilingual children can sometimes produce constructions that are either ungrammatical or odd in one language, but more acceptable and/or frequent in their other language. Such errors are usually seen as manifestations of negative transfer (Argyri & Sorace, 2007; Döpke, 1998, 2000; Hulk & Müller, 2000; Müller & Hulk, 2001; Nicoladis, 2002, 2006; Serratrice, 2007; Serratrice, Sorace & Paoli, 2004).

A crucial question is at what level (negative) transfer operates. One possibility is that bilinguals have different linguistic representations from monolinguals. In this case, transfer errors should pertain to all levels of linguistic behaviour (language production and language comprehension) and under all circumstances (e.g., when the processing load is high and when it is low). Alternatively, transfer errors may be caused by performance limitations. In this scenario, bilingual children have the same linguistic knowledge as their monolingual peers, but sometimes make transfer errors (in production or comprehension) when they do not have enough processing resources for the task at hand. One of the factors that may influence the number of errors a child makes is the processing load associated with producing language (e.g., Nicoladis, 2006). When children produce language, they translate the message at the conceptual level into linguistic code that is understood by the hearer. This involves selecting the words that correspond to the entities at the conceptual level and combining them into grammatical sentences and coherent discourse. For bilingual children, this means selecting the words from the language currently in use instead of their other language, and adhering to the grammatical structure and the pragmatic conventions of the target language. This may result in competition between the structures from the languages that the child knows, and hence lead to errors (MacWhinney, 2005). These errors may be due to cross-linguistic transfer, when the child chooses a structure from the language that is not the target language. Also, the errors may

be due to the processing load becoming too high for the child to make use of the knowledge that they have.

Several studies have found that cross-linguistic influence may vary between tasks (e.g., Nicoladis, 2002; Chondrogianni & Marinis, 2012; Chondrogianni, Vasić, Marinis & Blom, 2015). For instance, Nicoladis (2002) showed that French–English bilingual children made more errors in compound nouns than their monolingual peers. They would name a group of chairs with flowers as 'chair flowers' instead of 'flower chairs'. However, in a less demanding receptive task, in which the children were asked to point to a named object, the groups did not differ.

The present paper adds to this line of research by investigating the processing of discourse connectives by German–Russian bilingual children, in both their languages. More specifically, we focus on additive connectives, i.e., connectives used to add or contrast information (e.g., *and, but*). Bilingual children are known to make many errors with Russian additive connectives and these errors are generally compatible with the properties of the other language they are acquiring (Tribushinina, Mak, Andreiushina, Dubinkina & Sanders, 2017; Tribushinina et al., 2017b). In this paper, we use an eye-tracking experiment in the Visual World Paradigm to test the hypothesis that such errors are caused by processing limitations rather than different (or incomplete) knowledge of semantic-pragmatic properties of the connectives. As additive connectives are part of discourse coherence, in the remainder of this section, we discuss prior research on cross-linguistic influence in the domain of discourse coherence in general and in the domain of discourse connectives in particular.

Cross-linguistic transfer in the domain of discourse coherence

An important language skill to acquire is the capacity to understand the relation between subsequent utterances (relational coherence), and also the ability to understand which persons, objects, and actions are being referred to in the discourse (referential coherence). Languages have a plethora of devices that enable the listener to understand what the relational and referential coherence in discourse is (e.g., connectives and pronouns, respectively). Children learn to make use of such devices, which implies learning their precise meaning and pragmatic function. For example, a child acquiring English learns that pronouns are used to refer back to entities that are accessible, whereas full noun phrases are used when an entity is introduced or reintroduced in the discourse (Ariel, 1990).

Languages differ in the way similar linguistic devices are used to create referential and relational coherence. For example, in a pro-drop language such as Italian, pronouns are often only used when the referent of the pronoun is emphasized (1). In English, leaving out the pronoun is not possible in this sentence, so the presence of the pronoun does not imply that the referent is emphasized.

(1) (Io) ho visto un gatto nero
      "(I) *have seen a black cat"

When children acquire more than one language, they learn to distinguish between the different language systems. With regard to the example above, it has been shown that children who acquire a null-subject language together with a language like English that does not have null subjects may have more difficulty acquiring the referential system with null subjects than their monolingual peers: they use more overt pronouns (see Paradis & Navarro, 2003 for

Spanish; Serratrice, Sorace & Paoli, 2004 for Italian; Hacohen & Schaeffer, 2004 for Hebrew; Haznedar, 2007 for Turkish). The overuse of overt pronouns by bilinguals could be explained as a result of language transfer from English to a null-subject language (Italian, Spanish, Hebrew, Turkish). The bilingual children, acquiring two languages with different properties at the same time, may transfer characteristics of one of their languages to the other language.

Transfer phenomena in the domain of referential coherence have been reported not only for language production, but also for language comprehension. In one such study, Serratrice (2007) used a picture selection task to study the interpretation of null and overt pronouns in Italian by eight-year-old Italian–English bilinguals, age-matched monolinguals and adults. The results demonstrate that bilinguals are more likely to interpret overt pronouns as co-referential with a subject antecedent (i.e., in [-topic shift] contexts) compared to monolingual children and adults. This pattern is likely to be due to cross-linguistic influence from English, where pronouns can be used in both kinds of contexts.

Serratrice, Sorace, Filiaci and Baldo (2009) used an acceptability judgment task to investigate sensitivity of Italian–English and Italian–Spanish bilinguals (aged 6–10) to specificity and genericity constraints in determiner use in plural contexts. In English, the definite determiner must be used in specific contexts (e.g., *These sharks look friendly*), but bare nouns must be used in generic contexts (e.g., *Sharks are dangerous*). In contrast, Italian and Spanish require definite determiners across both types of contexts. The children in their experiment were asked whether the sentence they had just heard was okay in English/Italian. In English, bilingual and monolingual children performed around chance level. The task was probably too demanding because both options (definite NPs and bare nouns) are possible in plural contexts, and even the adverbials highlighting specificity (*Here …*) *vs.* genericity (*In general, …*) did not help children to reject infelicitous sentences. By contrast, in Italian (where bare plurals are obviously ungrammatical) monolinguals and Italian–Spanish bilinguals showed a ceiling performance. However, Italian–English bilinguals performed less well and were more likely to accept bare nouns in generic contexts, especially if English was their dominant language. This finding reveals that acceptability judgments may also be affected by cross-linguistic influence.

This said, there is also evidence that cross-language transfer cannot be the only factor explaining errors in production and comprehension. A case in point is a study by Sorace, Serratrice, Filiaci and Baldo (2009) that investigated acceptance of null and overt pronouns in contexts with and without topic shift. In a forced-choice paradigm, the participants were asked to choose which of the two characters (who were still learning English/ Italian) spoke better. All groups correctly rejected null pronouns in English. In Italian, both English–Italian and Spanish–Italian bilinguals accepted null pronouns in [-topic shift] contexts more often than monolinguals. At least in the latter group this result cannot be due to language transfer, since Spanish is similar to Italian with regard to pronoun use (see Gagarina, 2012 for similar findings on Russian–German bilinguals). The authors suggest that an overt pronoun is a default option that children may resort to if they are still acquiring the system and/or when they do not have enough processing resources.

An acceptability judgment task may be quite demanding for children and even adults, as evidenced by the English results reported in Serratrice et al. (2009). Furthermore, there is recent evidence that performance on a grammaticality/acceptability

judgment task may be more susceptible to cross-language transfer than more implicit (and more natural) language processing tasks. Zufferey, Mak, Degand and Sanders (2015) have shown that Dutch-speaking adults made transfer errors in judging acceptability of discourse connectives in L2 English, and their performance on a grammaticality judgment task mirrored transfer-based errors in production (e.g., *The kids don't look very tired today. ?When they don't take a nap now, we can go out for a walk*). Similarly, French-speaking adults accepted erroneous uses of *if* in contrastive contexts (e.g., *The admission policy for foreign students is variable across universities. ?If in some of them all students can enroll, in others there is an entrance examination*). This error also reflects the properties of the L1 (French) counterpart and often results in transfer errors in the speech of French learners of English. Interestingly, in a reading task preceding the grammaticality judgment task, the eye-tracking record revealed that the same L2 participants were sensitive to violations in connective use (in the same sentences). Both L1 English speakers and L2 participants slowed down upon reading the incorrect connectives.

One possibility is that implicit processing is less vulnerable to transfer effects. In line with this explanation, Tokowicz and MacWhinney (2005) report that English-speaking adults learning L2 Spanish performed at chance on a grammaticality judgment task (especially in the judgment of gender agreement), whereas ERPs revealed their implicit sensitivity to violations in the domain of grammatical gender (unique L2 feature) and tense marking (where L1 and L2 are similar). Interestingly, their results showed no sensitivity to ungrammaticality in the domain where English and Spanish partly overlapped (number agreement in NPs). Another explanation of the finding reported by Zufferey and colleagues (2015) is that a grammaticality judgment task is more cognitively demanding than a reading task where the participants only have to read sentences from the screen and answer verification questions from time to time. A higher processing load may be associated with more infelicitous/incorrect uses and a higher probability of cross-language transfer.

Thus, in order to investigate to what extent a child has acquired a certain linguistic rule or phenomenon, it may be necessary to use a method that is less cognitively demanding than speech production and grammaticality judgment tasks. In this paper we will do this by investigating the online processing of additive connectives (and, but) by Russian–German bilinguals in their two languages using a Visual World Paradigm experiment. The children will not have any additional task apart from listening to sentences and looking at the pictures. Since the processing load associated with this task is relatively low, the participants should process discourse connectives the way monolingual peers do, if their underlying representations are not affected by cross-language transfer.

Production and comprehension of additive connectives by bilingual children

Earlier research has shown that Dutch–Russian bilinguals showed an asymmetry between production and comprehension of the additive connectives *i* "and" and *a* "and/but" in Russian, with non-target-like performance in a narrative elicitation task (Tribushinina et al., 2017a) and target-like performance in a simple comprehension task (Mak, Tribushinina, Lomako, Gagarina, Abrosova & Sanders, 2017). The additive connectives in Dutch and Russian reveal intriguing semantic and pragmatic differences. The use of *en* "and" in Dutch is very similar to the use of *and* in

English and the use of *und* in German. However, the use of the Russian additive connectives *i* and *a* is different. In general, *i* is used when the topic of the previous clause is maintained (see Example (2), where Lena is the topic of both clauses), whereas *a* is used when there is a shift in topic between two clauses (see Example (3), where the topic shifts from the boy to the girl).

(2) *Lena očen' ljubit katat'sja na kon'kax, i ona provodit mnogo vremeni na katke.*
"Lena likes skating very much, <u>and</u> she spends a lot of time on the skating rink."
(3) *Mal'čik risoval risunok, a devočka igrala s kukloj.*
"The boy was drawing <u>and</u> the girl was playing with her doll."

Exchanging the connectives *i* and *a* in (2) and (3) would lead to an infelicitous sentence, or at least a change in the meaning of the sentence. Note that in (2) and (3) the topic maintenance or shift goes hand in hand with reference maintenance and shift. After the connective *i* the reference is maintained, after the connective *a* there is a referent shift. This is the case in most sentences with *i* and *a* (see Mak, Tribushinina & Andreiushina, 2013). However, not in all cases of *i* reference is maintained: in (4), reference is not maintained, but since the topic of both clauses is the action of swimming, *i* must be used to connect the sentences. Also, when there is a contrast relation between the clauses, as in (5), the focus is on the contrast, and hence *a* must be used to connect the sentences, even though in (5) there is a reference to the boy in both sentences.

(4) *Mal'čik ljubit plavat', i devočka tože ljubit plavat'.*
"The boy likes swimming, <u>and</u> the girl likes swimming too."
(5) *Utrom mal'čik est kašu, a večerom on est frukty.*
"In the morning the boy eats porridge, <u>and</u> in the evening he eats fruit."

Even though there is only a subtle difference between the two connectives, it is important that a child learns to understand the differing pragmatic functions of these connectives: using the wrong connective may lead to an entirely different interpretation of the sentence: In (6), the use of *i* implies that the speaker intends a causal relation between the clauses: the girl looked scared *because* the boy yelled. Here, in a sense, the causal chain warrants topic maintenance.

(6) *Mal'čik zakričal, i devočka ispugalas'.*
"The boy yelled, <u>and</u> the girl got scared."
(7) *Mal'čik zakričal, a devočka vygljadela ispugannoj.*
"The boy yelled, <u>and</u> the girl looked scared."

Note, that the interpretation of the relation in (6) differs from the interpretation of the relation in (7): in (7) the connective *a* implies that there is *no* causal relation between the two segments. The most likely interpretation is that both the boy and the girl react to some outside event.

The ability to use the semantic information in the connective is important for the children, because the connectives may change the meaning of a sentence. Failure to process the semantic information in the connective may lead to misunderstanding of the intended meaning of the sentence. Take, for example, the exchange in (8).

(8) - A: *Ja tebja ljublju* - B: *I/A ja tebja*
      - A: "I love you" - B: "And I (love) you"

In both cases the connective in the answer would be translated with "and", but the meaning of the answer differs. With *i*, the state described by the verb is accentuated, stressing that the two speakers are both in love with the other. In the answer with *a*, B stresses the fact that not only A loves B, but that B loves A in return, emphasizing the opposite perspective. Another reason why knowing the distinction between *i* and *a* is important is the fact that the connective *i* is often used to mark a causal relation between two sentences, as explained in the introduction. Example (9) is the title of a comedy.

(9) *On idiot, i ja jego ljublju.*
      "He is an idiot and I love him."

Here, the use of *i* indicates that the speaker loves the 'he' *because* he is an idiot. Using *a*, which would be more appropriate here, would imply that the speaker loves the 'he' *even though* he is an idiot.

As is evident from the translations of the Russian examples, in English (and other Germanic languages such as Dutch and German) the distribution of the connectives is different. Even though *i* and *a* can both be translated by *and*, neither of the connectives is pragmatically similar to *and*. A bilingual child needs to acquire these distinctions between the two languages, in order to be able to produce pragmatically correct utterances and understand the pragmatics of other people's utterances.

In this study our objective was to test the comprehension of the connectives *i* and *a* in as natural a way as possible, without requiring the children to make any explicit judgment, since that interferes with the normal comprehension process. In addition, since the distinction between these Russian additive connectives is related to reference maintenance or shift, our study focused on that aspect of processing. As mentioned before, several studies have shown that bilingual children have difficulty with the correct use of the connectives *i* and *a* in production. Tribushinina et al. (2017a) showed that 8-year-old Dutch–Russian simultaneous bilingual children made many errors in the production of these connectives. Particularly, they had a tendency to use the connective *i* for shift-relations in contexts where this was not licensed by the possibility of interpreting the sentences as causally related (an example of such an error is given in 10).

(10) *Tam ptica prizemlilas', i sobaka za koškoj pobežala.*
       "There the bird landed, and the dog started chasing the cat."

The bilingual children made this error in 40% of the cases where they used *i* for reference shift, whereas their monolingual peers made this error in only 10% of the cases. Tribushinina et al. (2017b) found the same for Russian–German sequential bilingual children (4 to 6 years of age). Interestingly, they found that the number of these errors correlated positively with the length of exposure to German. Moreover, bilinguals overused *i* and underused *a* compared to monolinguals, even though research shows that both connectives are acquired at the same time. This suggests that the errors the bilingual children make are at least partly the result of cross-linguistic influence.

Since the connectives *i* and *a* encode information about reference maintenance or shift, language users may use this information to predict the referent of the upcoming linguistic input. This has been studied for Russian adults (Mak et al., 2013) and 5-year-old Russian children (Mak et al., 2017). Both groups showed as sensitive to the semantic properties of the connectives *i* and *a* when they processed linguistic input. In eye-tracking experiments using the Visual World Paradigm (VWP), the participants saw a screen with two animals, and heard sentences like (11) and (12). On hearing the first sentence, they looked at the animal that was referred to (the monkey and the cow in the examples below).

(11) *Obezjana begaet v parke, i ona takže plavaet v bassejne.*
       "Monkey runs in the park and she also swims in the swimming pool."
(12) *Korova ljubit tancevat', a Kot ljubit pet'.*
       "Cow likes dancing, and/but Cat likes singing."

When they heard the connective *a*, they were more likely to switch to the alternative picture than when they heard the connective *i*. Thus, they used the pragmatic function of the connectives to predict the most likely continuation of the discourse. Interestingly, 5-year-old bilinguals, like their monolingual peers, also used the connective to predict the most likely continuation (Mak et al., 2017). Thus, even though these children make many errors in production, they have acquired the crucial (but subtle) pragmatic distinction between the connectives.

These results may indicate that the children are perfectly capable of distinguishing the two language systems, and are not influenced by cross-linguistic interference. However, Mak et al. (2017) did not compare the performance of Russian monolinguals and Russian–Dutch bilinguals directly. It is possible that the effect (i.e., a greater tendency to switch to an alternative referent after *a*) is less strong in bilinguals, because two languages interact in their mind. The performance of the bilingual group can also be related to language dominance (cf. Argyri & Sorace, 2007). Furthermore, in the experiment described above the bilingual children were only tested in Russian. It is unclear to what extent these bilingual children process additive connectives in Dutch or German in a similar way as their monolingual peers. It may as well be the case that the more marked semantic-pragmatic profiles of the Russian additive connectives would influence the way their Germanic counterparts are processed. For one, the Interface Hypothesis (Hulk & Müller, 2000; Müller & Hulk, 2001) would predict transfer from Russian to Dutch/German, because in Dutch/German the connective 'and' is underspecified and used in both reference-maintenance and reference-shift contexts, whereas the Russian 'and' has a strong preference for reference maintenance and can only be used in reference-shift contexts under specific conditions. Even though the production studies report the opposite direction of transfer (Russian to Dutch/German), it is still possible that the online processing of Dutch/German connectives could be influenced by the language with a more specified distribution of additive connectives (Russian). In more general terms, we can never have a comprehensive picture of bilingual development by only looking at one language. For instance, by looking at vocabulary size in only one language, we could conclude that bilinguals have smaller vocabularies than monolinguals, whereas in both languages taken together bilinguals often have larger total vocabularies than monolinguals (Pearson, Fernández & Oller, 1993). Likewise, in order to understand the workings of cross-linguistic transfer in language processing, it is crucial to consider both languages of a bilingual child. Thus, we will study connective processing by Russian–

German bilingual children, in comparison with monolingual children in both languages.

This language combination is theoretically interesting because German additive connectives, like their counterparts in English and Dutch, but unlike their Russian counterparts, are not semantically specified for reference maintenance or shift and are therefore equally felicitous in both types of contexts. Hence, we can make predictions about the processing of *und* "and" and *aber* "but" in German based on the earlier results on the processing of the Dutch connectives *en* "and" and *maar* "but" by monolingual adults. The only research so far that tests whether additive connectives in Germanic languages are also used to predict the upcoming referent comes from Mak et al. (2013). They compared the processing of additive connectives by Russian and Dutch adults. Importantly, in a corpus study Mak and associates showed that in terms of frequency of reference maintenance, the Dutch connectives *en* "and" and *maar* "but" are very similar to the Russian connectives *i* and *a*. However, the connectives differ in that the Dutch connectives, like *and* and *but* in English, are interchangeable: Exchanging the connectives leads to a different meaning of the sentence, but never to an ungrammatical/infelicitous sentence, as is the case for the Russian connectives.

As mentioned above, the Russian adults used the connectives to predict the most likely referent of the next sentence. The Dutch adults did not differentiate in processing between the connectives *en* "and" and *maar* "but". Thus, even though the frequency of use of the connectives might be an indication of the most likely referent of the next clause, the Dutch participants did not use that information to predict the upcoming referent. These results show that additive connectives in Russian and Germanic languages are processed in two distinct ways, corresponding to the typologically different semantic-pragmatic profiles of the connectives in these languages. Therefore, this task seems particularly appropriate to determine whether bilingual children process connectives in their two languages in distinct ways, or whether their processing differs from that of monolingual speakers.

In this paper, we address the question of how bilingual children speaking Russian and German process the additive connectives in their two languages. They are acquiring the systems of those languages simultaneously, and hence it is possible that one of the languages influences the other. As Tribushinina et al. (2017b) have shown, German–Russian bilingual children make many errors in the production of the connectives *i* and *a*. Notice that these children were raised in Germany and were dominant in German. Hence, a possible explanation for this finding is that there is cross-linguistic influence from the children's dominant language (German) to their weaker language (Russian), in that the children treat the connective *i* in the same way as German *und*. If that is the case, the bilingual children may also show this influence in processing and may use the semantic information of the Russian connectives to a lesser extent than the monolingual children. In this scenario, bilingual children will be less likely than monolingual Russian-speaking children to shift gaze to the alternative picture upon hearing the connective *a* "and/but".

However, there may also be cross-linguistic influence in the opposite direction. As explained above, the Interface Hypothesis (Hulk & Müller, 2000; Müller & Hulk, 2001) would predict transfer from the language with fully specified connective semantics (Russian) to the language with underspecified connective semantics (German), irrespective of language dominance (but see Argyri & Sorace, 2007 and Serratrice et al., 2009 for the mediating role of language dominance). In this scenario, bilinguals may be more likely than German monolinguals to switch gaze to the alternative picture after *aber* "but" and less likely than German monolinguals to shift gaze to the alternative picture after *und* "and", following the patterns in Russian.

However, the production data may be a result of increased processing load rather than a different representation due to cross-linguistic influence. For instance, in the study discussed above Sorace et al. (2009) have found that not only English–Italian, but also Spanish–Italian bilinguals accepted null pronouns in [-TS] contexts more often than Italian monolinguals. They suggest that using an overt pronoun might be a default strategy that children may resort to if they are still acquiring the system and/or when they do not have sufficient processing resources for the task at hand. In a similar fashion, bilingual children may resort to the connective *i* "and" as a default or as a generic additive connective (just as they do with *und* in German), which may lead to the kind of production errors that were observed in the studies described above. In this scenario, their performance on a less cognitively demanding task (such as the eye-tracking experiments described above), should reveal target-like performance in both languages. Hence, when the processing load is low, the performance of the bilingual children should be very similar to that of monolinguals in the respective languages. The experiment reported below will test this issue and thereby shed more light on the cause of the production errors attested in prior work.

Method

Participants

The bilingual participants were 22 German–Russian bilingual children (11 female) living in Germany. All participants were born in Germany. They were exposed to Russian from birth and to German either from birth or within the first 2 years of life. Before school, they attended a monolingual German kindergarten. At the time of the experiment, all participants attended a bilingual German–Russian school in Berlin. Hence, they were fairly balanced bilinguals in terms of exposure and proficiency. The children were on average 7 years 3 months of age at the beginning of the study (range: 6;6–8;6). The parents/guardians of the children signed informed consent and filled in a short questionnaire about the language background of the children.

The German monolingual participants were 20 children (15 female) living in Germany. The children were on average 7 years 10 months of age at the time of the study (range: 6;3–8;10).

The Russian monolingual participants were 22 children (11 female) from St. Petersburg. The children were on average 8 years 2 months of age at the time of the study (range: 7;7–8;8).

Materials

We used the materials from earlier experiments (Mak et al., 2013, 2017). These consisted of four types of items. There were seven items of each type, twenty-eight items in total. All items consisted of a display with two animals. The display was accompanied by a set of two spoken clauses in either Russian or German. Examples of these sets of clauses are given in Table 1. There were two conditions – clauses conjoined by *i* and clauses conjoined by *a*. To make sure that the listeners would not be able to predict what the referential relation between the clauses would be on the basis of the materials, the second clause of a set either referred to the same referent as the first clause (maintenance conditions,

Table 1. Example sentences

Sentence type	Language	Sentence	English Translation
1. connective i/und (maintenance)	*Russian*	Obezjana begaet v parke, *i* ona takže plavaet v bassejne.	*Monkey runs in the park and s/he also swims in the swimming pool.*
	German	Der Affe rennt im Park *und* er schwimmt im Schwimmbad.	
2. connective i/und (shift)	*Russian*	Ovečka ljubit pit' moloko, *i* Svinja tože ljubit pit' moloko.	*Sheep likes milk, and Pig also likes milk.*
	German	Das Schaf mag Milch *und* das Schwein mag auch Milch.	
3. connective a/aber (maintenance)	*Russian*	Lev zimoj vsegda kataetsja na lyžax, *a* letom on vsegda plavaet v reke.	*Lion always goes skiing in the winter, and/but in the summer he always goes swimming (in the river).*
	German	Der Löwe geht jeden Winter Ski fahren *aber* im Sommer geht er immer (im Fluss) schwimmen.	
4. connective a/aber (shift)	*Russian*	Korova ljubit tancevat', *a* Kot ljubit pet'.	*Cow likes dancing, and/but Cat likes singing.*
	German	Die Kuh tanzt gerne *aber* die Katze singt gerne.	

Fig. 1. Example of the visual stimulus ('Zebra has never been to Russia, and Dog has also never been to Russia')

sentence types 1 and 2 in Table 1) or referred to a different referent (shift conditions, sentence types 3 and 4 in Table 1).

The Russian and German sentences were recorded by female native speakers. The sound files were manipulated in such a way that the connective started four seconds after the beginning of the trial and the second clause started five seconds after the beginning of the trial. This way we ensured the participants had one second to react to the connective before the second sentence started. The naturalness of the sentences was not affected because a post-conjunctional silence is a pervasive phenomenon in spoken language (e.g., Hawkins, 1971; Schilperoord, 1996; Swerts, 1998). Fourteen pictures of animals were used in the experiment. For each sentence type these pictures were combined in seven pairs. Each animal appeared four times in the experiment: once as the subject in a maintenance trial, once as the alternative picture in a maintenance trial, once as the subject of a shift trial and once as the object of a shift trial. A pair of animals did not appear twice.

The pictures of the animals were presented as in Figure 1. The position of the referent of the second clause (left or right on the screen) was counterbalanced. The four sentence types were randomly ordered, with the restriction that the same sentence type should not appear twice in a row.

The experiment was run on a Tobii T60 eye-tracker, sampling at 60 Hz (every 16.6 ms.) using Tobii Studio. The items were presented on a 17-inch monitor.

Procedure

The children were tested individually in a quiet room at their school. The children did not have any specific task. They were only asked to look at the pictures on the screen and listen to the sentences. Each bilingual child was tested in both languages, first in Russian and about a week later in German. The monolinguals in St. Petersburg and Berlin were tested in their respective languages only, Russian or German.

After a calibration procedure the experiment started. An experimental session took about 5 minutes.

Analysis

From the eye-tracking record we determined the position of the eye in 100-ms time steps. The final dataset was analysed by means of a multilevel logistic regression (Goldstein, 1999; Mirman, Dixon & Magnuson, 2008) in R using the lme4 package (Bates, Maechler & Bolker, 2013). This way we treated the eye-tracking data for each trial as longitudinal data. Thus, we could assess the change in the probability of looks to the target picture over time. By using a multilevel approach, we took into account the nested nature of the data: trials were nested within items and within subjects.

We modelled the probability of fixation on the target picture as a function of four predictors: Language (Russian vs. German), Group (bilinguals vs. monolinguals), Connective (*i* vs. *a*), and Time (in 100-ms time steps). Subjects and items were added as random factors. Since the fit of the models increased when we added random slopes, these were also included. We started with a base model with only the random effects. We then added the fixed effects of Language, Group, Connective, and Time. Finally, the interactions of these factors were added. Goodness of fit was computed to establish whether adding these components led to a better fit with the data. The analysis was done on the time interval from the onset of the connective (at 4 seconds after item

onset) until 200 ms after the beginning of the second sentence (5.2 seconds after item onset). The total duration of the time window we analysed was thus 1200 ms. We added this extra 200 ms because it takes approximately that time to initiate and compute a saccade in reaction to the external input (e.g., Saslow, 1966). Therefore, only 200 ms after the beginning of the second sentence the looks can reflect a reaction to the word following the connective.

We expected that, on hearing the first segment, the participants would look at the picture of the subject of the first segment. On hearing the connective, the participants may or may not switch to the alternative picture depending on the language and the connective that is used.

In Russian, if the participants use the semantics of the connectives, we expected that they would switch more on hearing the connective *a* 'and/but' than on hearing the connective *i* 'and', in the time interval between the onset of the connective and the onset of the subject of the second segment. For the monolingual Russian children we expected the proportion of looks on the alternative picture to show a stronger increase after *a* than after *i*. In German, on the other hand, the semantics of the connectives should not guide the participants' attention to either of the pictures. Hence, in the data of the German children, no difference in the increase of the proportion of looks at the alternative picture was expected between the connectives *aber* 'but' and *und* 'and'. For the bilingual children there were three options: first, they may distinguish entirely between the two languages, and pattern with the monolinguals in both languages; second, they may adopt the strategy of one of the languages, and apply it to the other; third, they may have an intermediate position between the languages, showing a difference in increase between *und* and *aber*, but not as strong as the difference between *i* and *a*.

In the model, the condition with the connective *und* for the German monolinguals was taken as the baseline. The other conditions were compared within the model with this baseline.

Results

The data are presented in Figures 2 (for German) and 3 (for Russian). The figures show the proportion of looks at the alternative picture (the picture of the animal that is not mentioned in the first clause), during the time between connective onset (at 4 seconds after item onset) and 200 ms after the onset of the rest of the second clause (which was at 5 seconds after item onset). This proportion starts low, as the animal in the alternative picture is not mentioned in the first clause, and shows a rise over time in this time frame. Adding the main effects to the base model improved the fit ($\chi^2(4) = 86.79$ p < .001). Adding the interactions again improved the fit of the model ($\chi^2(11) = 206.92$, p < .001). The latter model is given in Table 2.

In the results of the German monolingual children (parameters 1–4 in the model) there was a main effect of Time (parameter 3), representing an increase in the proportion of looks at the alternative picture for the German monolingual children when they heard the connective *und* "and". Parameter 4 shows the interaction of Time and Connective for the German monolinguals. It shows that there was no significant difference in the increase in looks at the alternative picture between sentences with *und* "and" and *aber* "but".

Parameters 5–8 in Table 2 describe whether the data of the bilingual children in German differs from those of the monolingual German children. Parameters 5 and 6 show that there is a

difference in intercept. The line for *und* is higher for the bilinguals than for the monolinguals (Parameter 5), and the difference between *und* and *aber* is not the same as for the monolingual group (Parameter 6). This means that there is a difference between the conditions at the beginning of the analysis window, which remains the same throughout the whole analysis window. It is not clear what causes these differences, but since the effect is present before the connective appears, it cannot be due to different reactions to the connective. The crucial question is whether the reaction to the connective (as reflected in a difference in increase in looks at the alternative picture) is different between the monolinguals and the bilinguals. This is neither the case for *und* (parameter 7) nor for the interaction of Connective and Time (parameter 8), is not different from the bilingual children. Taken together, the results for German show that in both groups and for both connectives, there was a similar increase in looks at the alternative picture.

Parameters 9–12 in Table 2 show the comparison of the monolingual Russian children with the monolingual German children. Parameter 11 tests whether there was a difference between the increase in looks to the alternative picture between *und* ("and") and *i* ("and"). The results show that the proportion of looks at the alternative picture increased significantly slower for Russian *i* ("and") than for German *und* ("and"). Parameter 12 shows that the increase that was found for Russian *a* ("and/but") was significantly faster than for German *aber* ("but").

Parameters 13–16 show the comparison between the monolingual Russian children and the bilingual children. There were no differences between these two groups.

Discussion

In this study we examined to what extent German–Russian bilingual children process additive connectives in their two languages in the same way as monolingual children speaking one of the two languages. The results of the monolingual groups show that there is a difference in the processing of additive connectives in German and Russian. The processing results in these groups are similar to the processing results of Dutch and Russian adults reported by Mak et al. (2013). For the German monolingual children there was no difference in processing between the connectives *und* and *aber*. For both connectives, the children showed a slight tendency to switch to the alternative picture upon hearing the connective. Importantly, this tendency was equally strong for both connectives. This result replicates the effect found by Mak et al. (2013) for Dutch adults processing the connectives *en* "and" and *maar* "but".

The Russian monolingual children, just like the Russian adults in Mak et al. (2013), showed differential processing of *i* and *a*: the tendency to switch to the alternative picture was stronger for *a* than for *i*. Note that this effect was both found in a weaker increase in looks at the alternative picture for *i* compared to *und*, and in a stronger increase in looks at the alternative picture for *a* compared to *aber*. Thus, the results for the two monolingual groups in this study provided a replication of the findings from Russian and Dutch adults reported in Mak et al. (2013).

The main question in this paper was whether children, who are acquiring Russian and German simultaneously, have acquired both systems to such an extent that their processing patterns in both languages are similar to those of monolingual children. The data show that this is the case: both in German and Russian, these children show the same processing pattern as
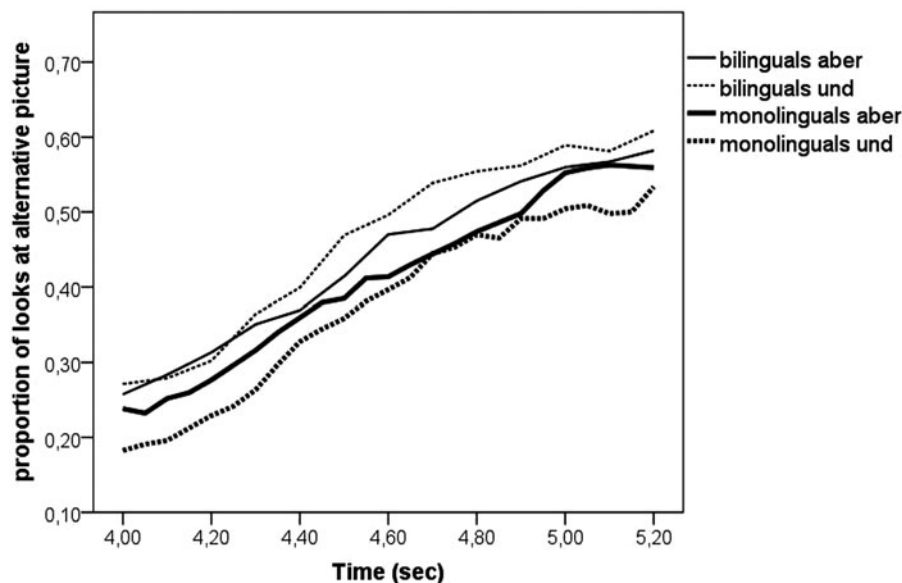
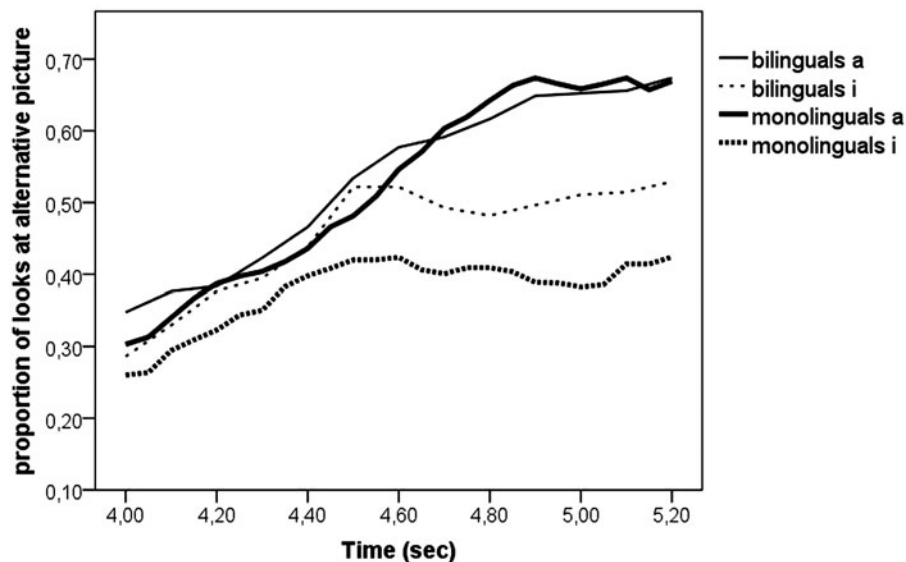**Fig. 2.** Proportion of looks at the alternative picture for German

Fig. 3. Proportion of looks at the alternative picture for Russian

their monolingual peers. Note that they do not just use the information in the connective to eventually arrive at an interpretation of the referent of the clause: like the monolingual Russian-speaking children they predict which animal will be referred to in the upcoming clause (in Russian). These results clearly show that in both languages the bilingual children have linguistic representations of the connectives that are similar to those of the monolinguals.

One might argue that the fixed order in which the two languages were presented to the bilingual children (Russian first, then German) might have affected their performance in German. However, any influence of this order would have implied that it was easier for them to predict the referent of the second clause in the German part. Therefore, the finding that there was no influence from Russian to German reinforces the conclusion that the children process the additive connectives in the two languages differently. Notice also that the Interface Hypothesis (Hulk & Muller, 2000) would predict cross-linguistic influence from Russian to

German, because the German additive connectives are underspecified for referential continuation. So this order of testing provides the most stringent test of these theoretical predictions.

The results are in line with the prediction that in a task like this, with a low processing load, the bilingual children perform similarly to the monolingual children. However, it may not simply be the processing load itself, but specifically the fact that in this task only one language is involved, and hence competition between the two languages is minimal. It is possible to distinguish between these two explanations by increasing the processing load either without introducing the other language (for example, by having the children memorise aspects of the pictures), or with a task that involves the other language (for example, by switching between the languages). This might help to establish how processing load plays a role in the ease with which the bilingual children distinguish between their language systems.

Obviously, there may have been differences between the monolingual and bilingual children that were not captured in this study,

Table 2. Fixed effects from the best fitting multilevel logistic regression model

	β	SE	Z	p
Monolingual German children				
1. Intercept	−0.549	0.141	−3.89	<.001
2. Connective(aber)	0.155	0.140	1.107	.26
3. Time	1.466	0.268	5.46	<.001
4. Connective(aber)*Time	−0.050	0.398	−0.125	.90
Bilingual children (German) versus *Monolingual German children*				
5. Group(BI)	0.399	0.147	2.717	.006
6. Group(BI)*Connective(aber)	−0.268	0.066	−4.048	<.001
7. Group(BI)*Time	−0.038	0.382	−0.099	.92
8. Group(BI)*Connective(aber)*Time	0.140	0.486	0.288	.77
Monolingual Russian children versus *Monolingual German children*				
9. Language(RUS)	−0.036	0.144	−0.251	.80
10. Language(RUS)*Connective(a)	0.547	0.055	10.005	<.001
11. Language(RUS)*Time	−1.074	0.364	−2.948	.003
12. Language(RUS)*Connective(a)*Time	1.230	0.496	2.480	.013
Bilingual children (Russian) versus *Monolingual Russian children*				
13. Group(BI)*Language(RUS)	0.004	0.153	−0.027	.98
14. Group(BI)*Language(RUS) *Connective(a)	−0.058	0.091	−0.636	.53
15. Group(BI)*Language(RUS)*Time	0.559	0.532	1.049	.29
16. Group(BI)*Language(RUS) *Connective(a)*Time	−0.637	0.642	−0.992	.32

Notes: BI = bilingual children; RUS = Russian

because the task might not be sensitive enough to capture them. However, we do know that this task distinguishes well between the languages (Dutch/German *vs.* Russian), and that the task distinguishes between typically-developing bilingual children and children with developmental language disorder (Mak et al., 2017).

Note also, that the children in this study are fairly balanced bilinguals, which is different, for example, from Dutch-dominant bilinguals studied by Tribushinina (2017a) and Mak et al. (2017). We have not tested production of *i* and *a* by these children. However, from earlier work on a similar group of Russian–German bilinguals (Tribushinina et al., 2017b) we know that balanced bilinguals also make errors with *i* and *a* in a narrative task. The participants in the present study attend a bilingual school, where they receive instruction in both languages. So they are not only bilingual, but also biliterate. One may argue that their target-like performance with *i* and *a* could be a result of their frequent exposure to written Russian texts. However, earlier research has shown that children that are biliterate still show differential performance with discourse connectives depending on the task they receive. Tribushinina, Mak and colleagues (2017a) studied Dutch–Russian bilingual children, who attend a regular Dutch school during the week and a complementary (weekend) school where they learn to read and write in Russian. In narrative elicitation tasks, Tribushinina et al. (2017a) show that 8-year old children made an error in 40% of the cases where they used *i* for reference shift. At the same time Mak et al. (2017) show that 5-year children at the same

complementary school performed similarly to a monolingual control group in the VWP-task. These results can be explained in terms of a higher processing load in the narrative elicitation task.

First, it is possible that the higher processing load in the narrative elicitation task, leads to cross-language transfer: the German–Russian bilingual children may use the Russian connective *i* where they would use the connective *und* in German, because *i* is conceptually more similar to *und* (both are purely additive), and *a* to *aber* (both express contrast).

A second explanation for the overuse of *i* may be that *i* is a more generic connective, and children may use it as the default when they lack the processing resources to select the correct connective in a certain context: they may tend to reserve *a* for cases where they would use *aber* in German. This would be comparable to the result of Sorace et al. (2009), described in the introduction, that Spanish–Italian bilinguals overuse overt pronouns in Italian, which has been taken as evidence of the default status of overt pronouns. The errors that the children make in previous studies on connective production (Tribushinina et al., 2017a) are comparable: in order to produce the correct connective, the children must pay attention to the topic (dis)continuity in their stories. If they do not take topic (dis)continuity into account, they produce the incorrect connective in many cases. Note that in the data of Tribushinina et al. (2017a) this effect is unidirectional: the errors concern cases where *i* is mistakenly used in cases of reference shift, not the other way around. There were a few errors with *a*, but these concern cases where *a* is used instead of the argumentative connective *no* ("but"). The conclusion then would be that the children take *i* as a default connective, and use *a* only when there is enough evidence for a reference shift, or when they have enough processing capacity to take the topic (dis)continuity into account when they produce the sentences.

The explanations above both rely on the assumption that *i* has a special status for the children (either because it is the default or because it is conceptually similar to the German connective *und*). Both *i* and *a* emerge early in child speech and have a high frequency in the input (Knjazev, 2007). Of course, logically, in production children may also resort to a strategy where they use the connectives interchangeably, sometimes exchanging *i* for *a*, and in other cases exchanging *a* for *i*. However, the production data for bilingual children do not support that idea, because their errors predominantly involve using *i* where they should use *a*.

The data of the present experiment show that Russian–German bilingual children have acquired the system for additive connectives in both their languages. Even though similar groups of bilinguals make errors in production (Tribushinina et al., 2017a; Tribushinina et al., 2017b), we find no evidence of differential processing of the connectives between monolingual children and bilingual children. Thus, the errors they make cannot be taken as an indication of a different language representation.

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