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Research Article

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Abstract

To assess the presence of cross-linguistic influence, this study compared the processing of Dutch sentences by English–Dutch and German–Dutch bilingual and Dutch monolingual children in a self-paced listening task. We combined insights from studies on child bilingualism and adult second language acquisition. Sentence structures showing partial overlap between languages were investigated (long passives), as well as structures with complete or no overlap (verb second and verb third sentences). We found evidence for syntactic co-activation of overlapping structures in the form of inhibition during listening. Syntactic, and possibly lexical, overlap between languages, and language dominance modulated effects. In particular, online cross-linguistic influence was visible only in the German–Dutch group. Furthermore, effects were most pronounced when structures partially overlapped and were absent in non-overlapping structures. Effects of online cross-linguistic influence became stronger the more German-dominant children were. Our results indicate that syntactic co-activation across languages affects sentence processing in bilingual children.

1. Introduction

An intensively studied topic in child bilingualism is the influence of a (morpho)syntactic property in bilingual children's one language on their other language. For example, a French–English bilingual child saying *apple green* instead of *green apple*, where French word order (Noun-Adjective) is used in English (Nicoladis, 2006). Studies on such cross-linguistic influence have traditionally investigated the interdependency of bilingual children's syntactic systems (e.g., Paradis & Genesee, 1996) and have focused on children's production and comprehension (see Serratrice, 2013, for an overview). Factors that might modulate cross-linguistic influence include language overlap (e.g., Döpke, 1998; Hulk & Müller, 2000; Müller & Hulk, 2001) and language dominance (e.g., Argyri & Sorace, 2007; Yip & Matthews, 2000).

To date, however, hardly anything is known about cross-linguistic influence in bilingual children during real-time language processing (cf. Lemmerth & Hopp, 2019). In contrast, recent studies with bilingual adults have typically employed online techniques to study syntactic interactions between languages. These have shown subtle effects of cross-linguistic influence during sentence processing (e.g., Hopp, 2017; Runqvist, Gollan, Costa & Ferreira, 2013). It is unclear whether similar effects are also present in bilingual children.

This study aimed to integrate insights from offline child and online adult studies to assess cross-linguistic influence during sentence processing in children. In doing so, we examined cross-linguistic influence during the processing of different Dutch word orders in English–Dutch and German–Dutch bilingual children by means of a self-paced listening task. Language overlap and dominance were systematically manipulated to test their role online.

2. Background

Cross-linguistic influence has been attested for various morphosyntactic properties, including word order (e.g., Argyri & Sorace, 2007; Döpke, 1998), compounding (e.g., Foroodi-Nejad & Paradis, 2009; Nicoladis, 2002), and pronoun use (e.g., Haznedar, 2007; Serratrice, Sorace & Paoli, 2004). To account for cross-linguistic influence, researchers have identified various predictors. Two are relevant to our study: language overlap and language dominance.

2.1 Language overlap and language dominance

Hulk and Müller (Hulk and Müller, 2000; Müller & Hulk, 2001) proposed that for cross-linguistic influence to occur there should be overlap between the child's two languages with Language α only allowing one structural analysis (X) and Language β two (X and Y). Language α may reinforce the use of structural analysis X in Language β (Hulk & Müller,

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2000; Müller & Hulk, 2001; also see Döpke, 1998). Following Unsworth (2003), we refer to such overlap as *PARTIAL OVERLAP*. Evidence for language overlap is mixed. Some studies have observed cross-linguistic influence with partial overlap (e.g., Foroodi-Nejad & Paradis, 2009; Haznedar, 2007), while others did not (e.g., Argyri & Sorace, 2007). Furthermore, there are studies that have found cross-linguistic influence in the absence of overlap (*NO OVERLAP*; see Serratrice, 2013). We are not aware of any offline studies investigating cross-linguistic influence in situations where a morphosyntactic property is completely shared between languages (*COMPLETE OVERLAP*).

Another factor found to predict cross-linguistic influence is language dominance (e.g., Argyri & Sorace, 2007). Language dominance has been operationalized in various ways, including (relative) language exposure and proficiency (e.g., Silva-Corvalán & Treffers-Daller, 2015). A recent meta-analysis showed that cross-linguistic influence is stronger from children's dominant language into their non-dominant language than vice versa (van Dijk et al., 2021). There are, however, studies where no such relation has been observed (e.g., Nicoladis, 2002; Serratrice, Sorace, Filiaci & Baldo, 2012).

2.2 Cross-linguistic influence during sentence processing

Language co-activation and priming

Findings from *ONLINE* tasks in adult second language (L2) acquisition have inspired recent theories on cross-linguistic influence in bilingual children. In adult bilinguals, there is ample evidence for language non-selective lexical access, even in monolingual situations (e.g., Dijkstra & van Heuven, 2002; Dijkstra, van Jaarsveld & ten Brinke, 1998; Marian & Spivey, 2003). Similarly, language co-activation at the sentence level has been observed in adults using structural priming: adults are more likely to use a certain structure in one language after having heard this structure in the other (e.g., Hartsuiker, Pickering & Veltkamp, 2004; Loebell & Bock, 2003). These findings suggest that in L2 adults structures in one language can activate similar structures in the other, even when this language is not in use. Over time, such cross-linguistic priming has been argued to result in shared syntactic structures between languages (Hartsuiker & Bernolet, 2017).

Various researchers have proposed that co-activation and cross-linguistic syntactic priming are the mechanisms underlying cross-linguistic influence in bilingual children, either indirectly through lexical co-activation (e.g., Nicoladis, 2006, 2012; Nicoladis, Rose & Foursha-Stevenson, 2010) or through shared syntactic structures (e.g., Serratrice, 2013, 2016). There is some evidence of cross-language syntactic priming in children (e.g., Hsin, Legendre & Omaki, 2013; Vasilyeva et al., 2010), but so far no direct evidence for syntactic co-activation in bilingual children *DURING* sentence processing.

Only a handful of studies have investigated sentence processing in bilingual children. Most involve early L2 learners rather than simultaneous bilinguals (cf. Lemmerth & Hopp, 2019), the main focus of work on cross-linguistic influence. These studies tested whether children's online behaviour was comparable to that of monolingual peers when processing morphosyntactic properties in one of their languages that were either similar (e.g., Lemmerth & Hopp, 2019; Marinis, 2007; Marinis & Saddy, 2013) or completely different from their other language (e.g., Chondrogianni, Vasić, Marinis & Blom, 2015b), or absent altogether (e.g., Chondrogianni, Marinis, Edwards & Blom, 2015a). Whilst most studies reported qualitatively similar results

for monolingual and bilingual children, only one (Lemmerth & Hopp, 2019) set out to test for cross-linguistic influence, and here, specific factors known from offline studies to be relevant for cross-linguistic influence (i.e., language overlap and language dominance), were not included. The role of these factors in bilingual children's online processing therefore remains unclear.

Online cross-linguistic influence in adult bilinguals

To better understand how cross-linguistic influence can manifest itself during sentence processing and how language overlap and dominance are involved we now turn to online studies with adult bilinguals. With respect to language overlap, our aim is to see whether type of overlap affects online cross-linguistic influence, and if so, what the mechanism is behind this. We first discuss evidence for online cross-linguistic influence with partially overlapping structures and then with no overlapping and completely overlapping structures. Second, we discuss the role of language dominance.

In language production, Runnqvist et al. (2013) found cross-linguistic influence to facilitate language processing in a situation of partial overlap. They investigated the timing of the production of English possessives by Mandarin-English, Spanish-English and monolingual English speakers. English allows for prenominal and postnominal possessives (i.e., *the woman's stroller is pink* versus *the stroller of the woman is pink*). Mandarin only allows prenominal possessives, whereas Spanish only allows postnominals. Hence, there is partial overlap between English and Mandarin, and between English and Spanish. Mandarin-English bilinguals were faster to produce the partially overlapping prenominal structure in English than the Spanish-English bilinguals, suggesting cross-linguistic influence from Mandarin.

The authors explained their finding in terms of frequency effects and made a direct connection between partial overlap – albeit not labelled as such – and cross-language priming. Given that the prenominal option is the only option in Mandarin, its relative frequency is higher compared to English, where a second option is available. Runnqvist et al. hypothesized that if overlapping structures are connected or shared between languages, the higher frequency of the prenominal possessive in Mandarin should to some extent be inherited by English. This explained why the Mandarin-English bilinguals were faster to produce the partially overlapping English prenominal structure: the higher frequency of prenominal possessives in Mandarin boosted the activation of the same structure in English.

Effects of partial overlap have also been investigated in online comprehension studies – albeit once again not discussed in these terms. In contrast to Runnqvist et al.'s (2013) production study, partial overlap in sentence comprehension seems to result in *LESS* efficient processing in L2 learners. Foucart and Frenck-Mestre (2012) investigated sensitivity to gender agreement violations in adjective-noun phrases in French L2 learners with English as first language (L1) in a situation of partial overlap and no overlap. The canonical position of French adjectives is postnominal (e.g., *les chaises vertes* – “the chairs green”). However, some adjectives appear in prenominal position (e.g., *les petites chaises* – “the small chairs”). Furthermore, French adjectives have to agree in gender with the noun they modify (e.g., *les chaises_{FEM} vertes_{FEM}* – “the chairs green” – versus **les chaises_{FEM} verts_{MASC}*). In contrast, adjectives in English are always prenominal and gender agreement is absent. Hence, the word orders of adjective-noun combinations in French and English constitute a situation of partial overlap with the less frequent

option in French (prenominal) overlapping with the only option in English.

Foucart and Frenck-Mestre measured participants' ERPs while participants listened to gender violations in French adjective-noun pairs. With non-overlapping postnominal adjectives, L2 learners were as sensitive to gender violations as native speakers. However, for overlapping prenominal adjectives, L2 learners showed less sensitivity – as evidenced by the absence of a P600 effect. These results suggest that with partial overlap the L1 affects L2 processing (see also e.g., Alemán Bañón, Fiorentino & Gabriele, 2014).

An explanation of why partial overlap can result in less efficient processing in an L2 comes from Hopp (2017). In an eye-tracking study, English L2 learners with German as L1 read reduced relative clauses in English (e.g., *When the doctor Sarah ignored tried to leave*). The order of such sentences corresponds to the canonical OV order in German (*Als die Ärztin Sarah ignorierte* – “when the doctor ignored Sarah”). Hence, reduced relative clauses in English overlap in form with SOV clauses in German but not in meaning. Furthermore, the frequency of word orders differs between languages. In German, SOV is the canonical and therefore a highly frequent word order in main clauses. In English, the linear order of reduced relative clauses does not correspond to the canonical SVO structure of English (e.g., Lehmann, 1978). Hence, there is partial overlap in reduced relative clauses between English and German in the sense that the surface word order is similar in both languages, but structural representations differ in meaning and frequency.

Hopp found that German L2 learners of English slowed down when reading reduced relative clauses. He explained his findings in terms of syntactic co-activation and inhibition. He argued that the English word order of reduced relative clauses activated the canonical SOV order in German. As a consequence, processing resources had to be allocated to inhibit the German structure which was visible as a slowdown effect during reading.

A similar explanation can account for the findings by Foucart and Frenck-Mestre (2012). Processing of non-canonical French prenominal adjectives might strongly co-activate the canonical English prenominal adjective-noun structure in L1-English L2 learners of French. As a consequence, French L2 learners have to allocate processing resources to inhibit co-activation of English, leaving fewer processing resources available to detect gender violations, resulting in different processing patterns in L2 learners compared to native speakers.

Evidence of cross-linguistic influence in adult bilingual sentence processing in situations of no overlap and complete overlap is less clear. On the one hand, studies like Foucart and Frenck-Mestre's (2012) suggest that L2 learners can process language similarly to native speakers in situations of no overlap. The same has also been found for situations of complete overlap (e.g., Alemán Bañón et al., 2014). At the same time, results from other ERP studies suggest that in both no and complete overlap situations language processing by L2 learners might be less automatized compared to native speakers (e.g., Andersson, Sayehli & Gullberg, 2019; Gillon Dowens, Guo, Guo, Barber & Carreiras, 2011). However, it is unclear whether differences between L2 learners and native speakers are due to cross-linguistic influence or due to other factors such as proficiency and processing demands.

With regard to language dominance, studies on sentence processing in bilingual adults show mixed effects. Some studies have found that cross-linguistic influence from the L1 in the L2 is strongest in less proficient L2 speakers (e.g., Alemán Bañón, Fiorentino & Gabriele, 2018; Hopp, 2017). Hence, the more dominant the L1,

the stronger online cross-linguistic influence becomes. Other studies have observed online cross-linguistic influence in highly proficient L2 learners as well (e.g., Foucart & Frenck-Mestre, 2012; Gillon Dowens et al., 2011), or even from the nondominant into the dominant language (Runnqvist et al., 2013).

In sum, if we look at the adult bilingualism literature through the lens of the child bilingualism literature we observe a number of parallels. First, one language's morphosyntactic properties can influence another language's morphosyntactic properties, resulting in less efficient processing in adults during listening (and reading). Second, language overlap and language dominance, predictors of cross-linguistic influence in children, seem to affect online cross-linguistic influence in adults as well. Online effects of cross-linguistic influence seem most pronounced in situations of partial overlap and in language learners who are dominant in the language not in use.

2.3 The present study

We investigated the presence of cross-linguistic influence during sentence processing in English–Dutch and German–Dutch bilingual children as related to language overlap and language dominance. In a self-paced listening task, we systematically manipulated the word order of long passives and verb second (V2) structures in Dutch. Children processed sentences that, between their languages: completely overlapped; partially overlapped; or did not overlap.

The long passive in Dutch, English, and German

Dutch passives can be formed with the auxiliary *worden* (“to become”) and a past participle. The agent is expressed in an optional by-phrase either following (V-PP; 1) or preceding the past participle (PP-V; e.g., Koster, 1974; 2).

- (1) De jongen wordt geduwd door het meisje.
the boy is being pushed by the girl
“The boy is being pushed by the girl.”
- (2) De jongen wordt door het meisje geduwd.
the boy is being by the girl pushed
“The boy is being pushed by the girl.”

Both word orders are grammatical, but there is evidence that the V-PP word order is preferred by native-speaker adults (Bernolet, Hartsuiker & Pickering, 2009).

Like Dutch, the English long passive is formed by an auxiliary, a participle and a by-phrase:

- (3) The boy is pushed by the girl.

Because English has a rather rigid SVO word order (e.g., Lehmann, 1978) the equivalent of the Dutch PP-V word order is ungrammatical:

- (4) *The boy is by the girl pushed.

German passives are similar to Dutch and can be formed with the auxiliary *werden* (“to become”) and a past participle (e.g., Verhagen, 1992; 5).

- (5) Der Junge wird von dem Mädchen geschubst.
the boy is being by the girl pushed
“The boy is being pushed by the girl.”

In German sentences with composite verb forms, NPs and PPs must appear between the auxiliary and main verb (e.g., Dürscheid, 2012). Consequently, in long passives the by-phrase precedes the verb (i.e., PP-V). Although the V-PP word order is, therefore, strictly speaking ruled out, movement to the right of the verb does sometimes occur (e.g., for stylistic reasons), especially in spoken language (e.g., Betz, 2008; Dürscheid, 2012; Haider, 2010; 6).

- (6) ?Der Junge wird geschubst von dem Mädchen.
the boy is being pushed by the girl

In line with Hulk and Müller (2000), the long passive constitutes a situation of partial overlap both between Dutch and English and Dutch and German: Dutch has two possible structures (PP-V and V-PP) whereas English (V-PP) and German (PP-V) only have one. Consequently, frequency distributions of the PP-V and V-PP word orders differ between languages. In Dutch, children's exposure to long passives is divided between the PP-V and V-PP structure – with the V-PP structure being potentially the more frequent one. In German, the PP-V structure is the only grammatical option, just as the V-PP structure is in English. Hence, the PP-V and V-PP orders are by definition relatively more frequent in, respectively, German and English, than in Dutch.

To our knowledge, no studies have investigated cross-linguistic influence in children's production and interpretation of long passives.

Verb placement in Dutch, English and German

Our complete/no overlap property is verb placement in non-subject-initial sentences: in this case, Dutch and German overlap completely, and English and Dutch not at all.

Dutch is a V2 language. In main clauses, the second constituent position is occupied by the finite verb (e.g., Koster, 1975; Zwart, 2011). When a constituent other than the subject occurs in first position, the verb raises past the subject and moves to the complementizer position, creating an XVS0 word order (e.g., Koster, 1975; Zwart, 2011; 7). Sentences with XSVO order (henceforth V3; 8) are ungrammatical in Dutch.

- (7) Gisteren at het meisje een appel.
yesterday ate the girl an apple
“Yesterday the girl ate an apple.”
(8) *Gisteren het meisje at een appel.
yesterday the girl ate an apple

As noted above, English declarative clauses maintain a strict SVO order, irrespective of the constituent in first position (Lehmann, 1978; 9 cf. 10). Only under limited circumstances does the finite verb move to the second constituent position (Radford, 2004).

- (9) Yesterday the girl ate an apple
(10) *Yesterday ate the girl an apple.

Similar to Dutch, German is a V2 language and subject-verb inversion is required when a constituent different from the subject occupies first position (e.g., Haider, 2010):

- (12) *Gestern das Mädchen aß einen Apfel.
yesterday the girl ate an apple

- (13) Gestern aß das Mädchen einen Apfel.
yesterday ate the girl an apple

The V2 structure constitutes a situation of complete overlap between Dutch and German and should have similar frequency distributions in the two languages. V3 is ungrammatical in both languages, making overlap irrelevant. Between Dutch and English, however, the V2 and V3 structures constitute a situation of no overlap.

There is some evidence for cross-linguistic influence in verb placement between English and V2 languages in simultaneous and sequential bilingual children's sentence production and judgements (e.g., Bosch & Unsworth, 2020; Döpke, 1998; Unsworth, 2016). These findings suggest that Dutch V2 and English V3 structures can influence each other in bilingual language development.

Research questions and hypotheses

Our first research question asks to what extent cross-linguistic influence occurs during English–Dutch and German–Dutch children's real-time processing of long passives and V2 and ungrammatical V3 structures in Dutch. If a syntactic structure in a bilingual child's one language can activate the same structure in their other language, as priming studies suggest (e.g., Hsin *et al.*, 2013; Nicoladis, 2012; Serratrice, 2016; Vasilyeva *et al.*, 2010), we expect this co-activation to become visible during sentence processing.

We predict that co-activation is manifested through inhibition effects in our self-paced listening task. Outcomes from online COMPREHENSION studies with adult L2 learners suggest that processing a sentence structure in an L2 which is similar in the L1 can result in less efficient processing (e.g., Foucart & Frenck-Mestre, 2012; Hopp, 2017): the word order in one language activates the same word order in the other language giving rise to processing latencies. We therefore expect English–Dutch children to slow down when listening to V-PP structures in Dutch and German–Dutch children when listening to PP-V and V2 orders. Listening to one of these structures in Dutch will activate the same structure in English/German. We suppose that this will lead to spreading activation in the last two languages. In turn, bilingual children will have to allocate processing resources to inhibit the activation of English/German, which will result in delays during listening.

We further hypothesize that language overlap modulates the relative amount of co-activation of the language not in use and – consequently – the strength of cross-linguistic influence online. That is, we expect online cross-linguistic to be strongest in a situation of partial overlap, less strong in a situation of complete overlap, and absent in a situation of no overlap. We explain this in terms of frequency effects, in line with Runnqvist *et al.* (2013).

In the case of partial overlap, structures are more frequent in the language with only one option than in the language with multiple options (i.e., V-PP for English–Dutch and PP-V for German–Dutch). Consequently, these structures should be more easily activated in English and German than in Dutch – assuming equal exposure to both languages. If structural co-activation across languages results in delay, partial overlap will strengthen this. If the relative frequency of a structure is higher in English or German than in Dutch, processing this structure in Dutch is likely to strongly co-activate the overlapping structure in English/German. Moreover, activation of the same structure in Dutch might be relatively weak, as the structure is less frequent. Hence, a relatively large amount of processing resources would

have to be allocated to inhibit co-activation of English/German, resulting in delays online.

In the case of complete overlap (i.e., V2 for German–Dutch), frequency distributions are equal across languages. As a consequence, the amount of co-activation German receives while processing the V2 order relative to activation of Dutch will be less compared to a situation of partial overlap. Therefore, we predict weaker effects of inhibition and shorter delays for V2 sentences.

In the case of no overlap (i.e., PP-V, V2 and V3 for English–Dutch and V-PP and V3 for German–Dutch), we predict no syntactic co-activation across languages. Because these word orders are absent in Dutch and/or English or German, there is no equivalent word order to prime while processing Dutch sentences. Therefore, we expect no additional co-activation of English or German and, consequently, no inhibition or delay in comparison to the other conditions.

Our second research question asks to what extent language dominance predicts the strength of cross-linguistic influence. We hypothesize that cross-linguistic influence becomes stronger the more dominant children are in English or German, similar to findings from offline studies with children (e.g., Bosch & Unsworth, 2020; Foroodi-Nejad & Paradis, 2009) and online studies with adults (e.g., Alemán Bañón et al., 2018; Hopp, 2017). In line with accounts that consider language co-activation as a possible source of cross-linguistic influence, we expect greater co-activation of the structural representations of the language not in use when that language is more dominant. Consequently, slow-down effects should increase the more dominant children are in English or German.

3. Method

3.1 Participants

Forty 5- to 9-year-old English–Dutch (mean age = 7.15, $SD = 1.37$, range = 5.1–9.8) and 42 German–Dutch bilingual children (mean age = 7.13, $SD = 1.48$, range = 5.0–9.6) participated. They had acquired both languages from birth (26 English–Dutch bilinguals; 32 German–Dutch bilinguals), or English/German from birth and Dutch before age 4.

Dutch monolingual children ($n = 39$) served as controls (mean age = 7.26, $SD = 1.27$; range = 5.1–9.9). Groups were matched on age ($F(2, 118) = 0.105$; $p > .1$) and socioeconomic status, measured in terms of whether parents had finished tertiary education (Fisher's exact test: maternal education level: $p > .05$; paternal education level: $p > .1$). Parents gave written or digital consent.

Information about children's patterns of language exposure was collected using a parental questionnaire (Bilingual Language Exposure Calculator; Unsworth, 2013). Children's current relative exposure (CURRENT INPUT) and their relative exposure over time (CUMULATIVE INPUT) to both languages were calculated based on children's language input in different contexts (at home, at school, etc.). These two measures served as a proxy of children's language dominance (following e.g., Unsworth, Chondrogianni & Skarabela, 2018). An overview of background variables is presented in Table 1.

3.2 Materials and design

Self-paced listening task

A self-paced listening task measured children's online sentence comprehension (Ferreira, Henderson, Anes, Weeks &

McFarlane, 1996). In this task, suitable for younger children (e.g., Booth, Mac Whinney & Harasaki, 2000; Marinis, 2010), children listen to sentences segment by segment using a button-box.

Thirty pairs of test sentences were created: 15 for each structure (Table 2, for a complete list of stimuli see Table S1 and S2 in the supplementary material). We selected lexical items from preschool word lists (Bacchini, Boland, Hulsbeek, Pot & Smits, 2005; Zink & Lejaegere, 2002). All but one verb in the passive sentences were taken from Armon-Lotem et al. (2016). Sentences were cut constituent-by-constituent rather than word-by-word to limit the number of interruptions during listening, keeping sentence processing as natural as possible. Critical regions were segments 3 and 4 for the passives and segments 2 and 3 for the V2/V3 sentences, and segment 5 and segment 4, respectively, were the spill-over regions. All items were recorded by a female native speaker using neutral prosody and intonation and were segmented afterwards. Pictures of animals (without acting out the actions) were shown in a random position on the screen to offer visual support. Comprehension questions were asked after 8 passive and 8 V2/V3 items (equal number of *yes* and *no* responses); these did not query the critical region itself.

Stimuli were distributed over pseudo-randomized lists. Each sentence only appeared in one condition. For each child a pair of identical lists was constructed differing only in word order, such that children listened to every sentence in both conditions. The experiment was created in E-Prime, version 2.0 (Schneider, Eschmann & Zuccolotto, 2002).

Children were first presented with 10 practice items (5 long passive and 5 V2/V3 clauses), receiving as much feedback as necessary for them to understand the task. To move from audio segment to audio segment, they pressed a button. It was possible for them to move to the next audio fragment before a previous fragment ended, but they could not go back. Each experimental list was divided into 5 blocks of 6 items, with breaks throughout.

Sentence repetition tasks

Sentence repetition tasks (SRTs) measured children's Dutch and German/English proficiency (LITMUS-SRep; e.g., Hamann & Abed Ibrahim, 2017; Marinis & Armon-Lotem, 2015). In addition to involving a memory component, sentence repetition tasks assess lexical and morphosyntactic language skills (e.g., Polišká, Chiat & Roy, 2015). The Dutch and English tasks consisted of 30 sentences. For German, 30 of the 45 sentences in the original short task were selected to match the Dutch and English sentences in terms of the (difficulty of) structure.

All sentences were recorded by native speakers. For English, a British and an American version were created. Sentences were presented auditorily in a Powerpoint presentation through headphones.

Children received one point for repeating a sentence verbatim – with a maximum of 30 points – and no points otherwise. In the German task, the chances of making an error were considerably higher compared to the other two languages due to gender and case. Consequently, gender and case errors on German determiners were ignored unless they resulted in a different meaning.

Children's scores on the SRTs were used as a third measure of language dominance. We calculated relative proficiency scores by subtracting children's score on the English/German task from the Dutch task (Unsworth et al., 2018; Yip & Matthews, 2006). A differential score higher than 0 thus meant that children were more

Table 1. Overview of background variables for bilingual children (means, standard deviations and ranges).

		English-Dutch	German-Dutch	Dutch	Statistics ^a
Country of birth	Netherlands (n)	34	41		
Age of first exposure to Dutch	(months)	3.6 (7.6) 0-32	4.1 (9.9) 0-36		$W = 910; p > .1$
	AoA > 1;0 (n) ^b	4	5		
Cumulative input	English/German (%)	48.5 (20.7) 8.1-85.2	45.4 (19.7) 15.5-90.9		$W = 912; p > .1$
Current input	English/German (%)	38.9 (19.2) 9-82	35.5 (16.5) 11-72		$t = .86; p > .1$
SRT	Dutch (max. 30)	19.1 (8.0) 2-29	21.6 (6.9) 4-30	21.0 (6.4) 4-30	$F(2,114) = 1.3$ $p = .266$
	English/German (max. 30)	16.2 (8.0) 2-29	17.6 (7.8) 0-30		$F(1,77) = 0.6$ $p = .432$
	Difference score	2.9 (8.5) -19-20	4.1 (7.7) -19-22		$F(1,77) = 0.4$ $p = .529$
Digit span	Forward	23.5 (2.8) 18-29	21.7 (4.2) 12-30	22.2 (3.5) 14-31	$F(2,114) = 2.5$ $p = .087$
	Backward	9.6 (3.1) 6-19	9.3 (4.5) 4-24	8.8 (3.0) 1-16	$F(2,114) = 0.5$ $p = .622$
WNV	Standard scores	103.4 (9.5) 84-123	102.1 (12.5) 74-128	105.5 (10.4) 81-126	$F(2,114) = 0.9$ $p = .392$

^aANOVAs for comparisons between three groups and t-tests or Wilcoxon-rank sum test for comparisons between two groups. ^bNumber of children whose age of onset of acquisition of Dutch was after 12 months.

Table 2. Examples long passive and V2/V3 sentences in self-paced listening task in PP-V, V-PP, V2 and V3 order.

	Segment						
	1	2	3	4	5	6	7
PP-V	de leeuw	wordt	door de beer	gekieteld	en	de muis	likt aan een ijsje
	<i>the lion</i>	<i>is</i>	<i>by the bear</i>	<i>tickled</i>	<i>and</i>	<i>the mouse</i>	<i>licks an ice cream</i>
V-PP	de leeuw	wordt	gekieteld	door de beer	en	de muis	likt aan een ijsje
	<i>the lion</i>	<i>is</i>	<i>tickled</i>	<i>by the bear</i>	<i>and</i>	<i>the mouse</i>	<i>licks an ice cream</i>
Comprehension question: Likt de muis? <i>licks the mouse</i> Is the mouse licking?							
	Segment						
	1	2	3	4	5		
V2	op de bank	zingt	de slang	een liedje	van school		
	<i>on the couch</i>	<i>sings</i>	<i>the snake</i>	<i>a song</i>	<i>from school</i>		
V3	*op de bank	de slang	zingt	een liedje	van school		
	<i>on the couch</i>	<i>the snake</i>	<i>sings</i>	<i>a song</i>	<i>from school</i>		
Comprehension question: Is de slang onder de bank? <i>Is the snake under the couch</i>							

proficient in Dutch than English or German, whereas the reverse pattern was reflected in a score lower than 0.

Digit span task

A forward and backward digit span task measured children's verbal short-term and working memory abilities (Automated Working

Memory Assessment: Alloway, 2012). The standard scoring procedure was used (forward: max. 48; backward: max. 36).

Wechsler non-verbal intelligence scale

To ensure comparability across groups, nonverbal intelligence score was measured using two subtasks from the Wechsler

Nonverbal-NL (WNV; Wechsler & Naglieri, 2008), *Matrix reasoning*, and *Recognizing for 5-to-7-year-olds* and *Spatial orientation* for 8-and-9-year-olds.

3.3 Procedure

Children were tested during two test sessions at home or school, approximately one week apart (minimum two days, maximum 3 weeks). The order of tasks was: self-paced listening, WNV, digit span and Dutch SRT in session 1, and self-paced listening and English/German SRT in session 2, before which children watched a short 3-minute movie in English/German to facilitate the language switch.

3.4 Data preparation

A-prime scores were calculated for the comprehension questions, with .5 showing chance performance and 1 indicating perfect performance (e.g., Stanislaw & Todorov, 1999). Two English–Dutch, one German–Dutch and one monolingual child were at or below chance (< .55) and thus excluded from further analyses.

Segments in the self-paced listening task differed in audio length. This is a common issue in self-paced listening and reading tasks (e.g., Chondrogianni et al., 2015a; Ferreira & Clifton, 1986). Following standard procedures (e.g., Marinis, 2010), we therefore calculated residual reaction times (RTs) by subtracting the duration of each audio fragment from participants' raw RTs. Residual RTs above 2500 ms and below 300 ms were removed. Because the distribution of the residual RTs was positively skewed, the data were log transformed.¹ Next, we removed data from children and items deviating more than 2.5 standard deviations from the mean of a segment (one monolingual child in the passive condition). Finally, we removed outlier trials, defined as 2.5 SDs above or below the segment mean by group, word order and child. Less than 3.5% of the RTs in the long passives and in the V2/V3 sentences were removed.

4. Results

4.1 Background measures

Table 1 shows the results on the background measures. There were no significant differences between groups.

4.2 Self-paced listening task

All data were analysed using multi-level linear effects analyses in R (version 4.0.3, R Core Team, 2020; package lme4, version 1.1-23, Bates, Maechler, Bolker & Walker, 2015; and lmerTest, version 3.1-2, Kuznetsova, Brockhoff & Christensen, 2017). An alpha level of .05 was used for all statistical tests. Continuous variables were grand-mean centered. Analyses contained random intercepts by Item and Participant, random slopes by Word order and Segment by Participant, fixed effects of children's Age, RT on the previous trial (following Baayen & Milin, 2010), Trial number, Forward digit span and Duration of the audio fragment and the interaction between Segment and Word order.²

¹When children had pressed the button before the end of a sound fragment, residual RTs were negative. To these residual RTs a constant was added before applying the log-transformation.

²Despite subtracting the duration of the audio fragments from children's total RTs, a relationship remained between audio duration and residual RTs: the longer an audio fragment,

When a model did not converge, random slopes and intercepts were removed until the model did converge. For all models, we removed data points with absolute standardized residuals exceeding 2.5 (less than 3.0% data removal for each model).

To assess effects of cross-linguistic influence we ran models with children's residual RTs on the pre-critical region (long passives: segment 2; V2/V3: segment 1), the critical region and the spill-over region as dependent variable. First, we tested the main effect of Group (English–Dutch, German–Dutch and monolingual Dutch). Second, we tested the 3-way interaction between Group, Word order (PP-V/V-PP and V2/V3) and Segment. A main effect or interaction was deemed significant when it significantly improved the fit of a model without the effect or interaction. Significant effects and interactions were explored using model summaries containing treatment contrasts. Models were relevelled when necessary.

To test for effects of language dominance we ran separate models for the two bilingual groups. We used three dominance measures: percentage Current input and Cumulative input in English/German and Relative proficiency (SRT differentials). In these analyses we only included the critical and spill-over segments. First, we tested 2-way interactions between the three dominance measures and Word order. Second, we tested the 3-way interactions between the dominance measures, Word order and Segment. Because the three dominance measures strongly correlated (English–Dutch: Relative proficiency and Cumulative input: $r = -.69$, $p < .001$; Relative proficiency and Current input: $r = -.80$, $p < .001$; Current input and Cumulative input: $r = .90$, $p < .001$; German–Dutch: Relative proficiency and Cumulative input: $r = -.70$, $p < .001$; Relative proficiency and Current input: $r = -.71$, $p < .001$; Current input and Cumulative input: $r = .88$, $p < .001$), we ran separate analyses for each. Similar procedures for significance testing and exploration of effects as discussed in the above were applied.

The datasets, scripts and output are accessible at <https://osf.io/6z3dp/>.

Long passive

Figure 1 shows children's average residual RTs in the PP-V and V-PP condition (for the average RTs and standard deviations, see Table S3, and for the residual RTs in the two word orders at each segment for the three groups, see Figure S4 in the supplementary material). Overall, the bilingual children had smaller residual RTs than the monolinguals. Furthermore, the German–Dutch group was slightly faster than the English–Dutch group.

The main effect of Group ($X^2 = 7.1$; $\Delta df = 2$; $p = .028$) and the 3-way interaction between Group, Word order and Segment ($X^2 = 20.0$; $\Delta df = 6$; $p = .002$) were significant. Simple interactions between Group and Word order in the model summaries showed that the effect of Word order in the German–Dutch group differed significantly from the effect of Word order in the other two groups at segments 4 and 5 (see Table 3). Word order did not differ significantly between the German–Dutch and the other children at segments 2 and 3, nor between the English–Dutch and the Dutch monolingual children at any segment.

At segment 4, the German–Dutch children were significantly slower in the PP-V condition than in the V-PP condition ($B = -0.0099$; $SE = 0.0033$; $t = -2.996$; $p = .003$). The RTs of the other two groups did not differ significantly between word orders,

the more time children had to prepare the button press, the smaller their residual RTs. Therefore, we removed this variance by adding audio duration as a predictor.

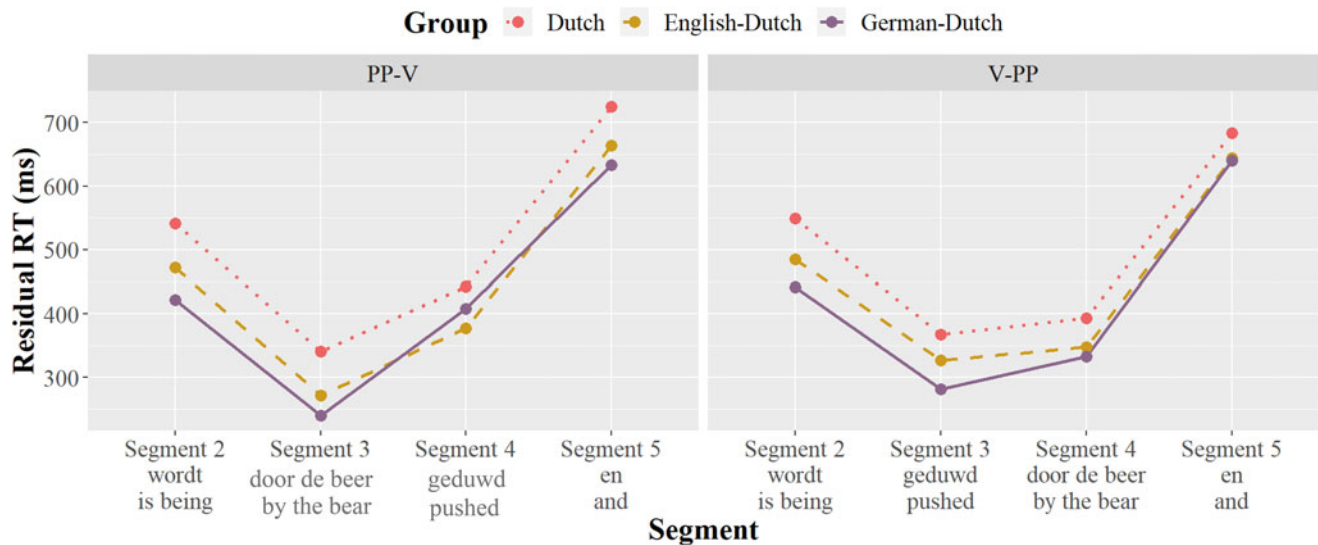


Fig. 1. Children's mean residual RTs in the PP-V (left panel) and V-PP (right panel) condition by group on segments 2, 3, 4, and 5.

Table 3. Simple interactions between Group and Word order in the long passive condition at segments 2, 3, 4 and 5. The model was relevelled based on Group and Segment.

		B	SE	t	p
Segment 2 wordt (<i>is being</i>)	Dutch vs. English-Dutch	-0.0032	0.0047	-0.678	.498
	Dutch vs. German-Dutch	-0.0043	0.0046	-0.929	.353
	English-Dutch vs. German-Dutch	-0.0011	0.0046	-0.240	.810
Segment 3 door de beer/geduwd (<i>by the bear/pushed</i>)	Dutch vs. English-Dutch	-0.0028	0.0048	-0.579	.563
	Dutch vs. German-Dutch	0.0007	0.0047	0.145	.885
	English-Dutch vs. German-Dutch	0.0035	0.0047	0.736	.462
Segment 4 geduwd/door de beer (<i>pushed/by the bear</i>)	Dutch vs. English-Dutch	0.0018	0.0048	0.378	.706
	Dutch vs. German-Dutch	0.0113	0.0047	2.389	.017
	English-Dutch vs. German-Dutch	0.0095	0.0047	2.004	.045
Segment 5 en (<i>and</i>)	Dutch vs. English-Dutch	-0.0054	0.0047	-1.148	.251
	Dutch vs. German-Dutch	-0.0160	0.0046	-3.470	<.001
	English-Dutch vs. German-Dutch	-0.0106	0.0046	-2.303	.021

however (monolinguals: $B = 0.0014$; $SE = 0.0034$; $t = 0.420$; $p = .675$; English-Dutch: $B = -0.0004$; $SE = 0.0034$; $t = -0.111$; $p = .911$).³ At segment 5, the German-Dutch children were significantly slower in the V-PP condition than in the PP-V condition ($B = 0.0076$; $SE = 0.0032$; $t = 2.380$; $p = .017$), whereas the other two groups were slower in the PP-V condition than in the V-PP condition. This effect of Word order only reached significance in the Dutch monolingual group ($B = -0.0084$; $SE = 0.0033$; $t = -2.523$; $p = .012$) and not in the English-Dutch group ($B = -0.0030$; $SE = 0.0033$; $t = -0.910$; $p = .363$).

³The estimates of Word order effects in the English-Dutch and Dutch groups go in the opposite direction than in Figure S4 because the models control for the effect of Duration (cf. fn. 2). Because on average, PP-V audio fragments were longer at segment 3 and shorter at segment 4 than V-PP fragments, Word order effects could change direction. Crucially, relative differences in residual RTs between groups remained similar.

To investigate what may have caused the differences between the German-Dutch group and the other groups at segments 4 and 5, we compared their residual RTs in the two conditions separately. Because the German-Dutch children were slightly faster overall than the English-Dutch and monolingual children, a direct comparison of residual RTs at segment 4 and 5 was not possible. Therefore, we explored whether the difference in residual RTs between the German-Dutch and the other two groups at pre-critical segment 2 became significantly larger or smaller at segments 4 and 5.

In the PP-V condition, the difference between the monolingual and German-Dutch children and the English-Dutch and German-Dutch children was significantly smaller at segment 4 than segment 2 (monolinguals: $B = 0.0202$; $SE = 0.0046$; $t = 4.367$; $p < .001$; English-Dutch: $B = 0.0107$; $SE = 0.0046$; $t = 2.321$; $p = .020$; see Table S5 in the supplementary material for

the model summary). This suggests that the German–Dutch children slowed down in the PP-V condition at segment 4. At segment 5, the difference in residual RTs in the PP-V condition between the German–Dutch group and the other two groups did not change significantly as compared to segment 2 (monolinguals: $B = 0.0048$; $SE = 0.0045$; $t = 1.063$; $p = .288$; English–Dutch: $B = -0.0004$; $SE = 0.0045$; $t = -0.088$; $p = .930$; see Table S6 in the supplementary material for the model summary at segment 5).

In the V-PP condition, the difference in residual RTs between the German–Dutch and the other two groups at segment 2 did not change significantly at segment 4 (monolinguals: $B = 0.0046$; $SE = 0.0046$; $t = 0.989$; $p = 0.323$; English–Dutch: $B = 0.0001$; $SE = 0.0046$; $t = 0.023$; $p = .982$). At segment 5 the difference between the German–Dutch group and the other two groups was significantly smaller compared to the difference at segment 2 (monolinguals: $B = 0.0172$; $SE = 0.0046$; $t = 3.763$; $p < .001$; English–Dutch: $B = 0.0091$; $SE = 0.0045$; $t = 2.000$; $p = .046$). This suggests that the German–Dutch children slowed down in the V-PP condition at segment 5.

Language dominance

See Table 4 for the interactions between the three dominance measures, Word order and Segment for the English–Dutch and German–Dutch children. Only the 2-way interaction between Relative proficiency and Word order in the German–Dutch group was significant (see Figure S7 in the supplementary material).

German–Dutch children's residual RTs became larger in the PP-V and V-PP conditions the higher their proficiency score was in German relative to Dutch. This slowdown was stronger in the PP-V than in the V-PP condition ($B = 0.0008$; $SE = 0.0003$; $t = 2.955$; $p = .005$). Children's residual RTs in the PP-V condition were significantly modulated by their Relative proficiency ($B = -0.0018$; $SE = 0.0008$; $t = -2.209$; $p = .033$). The effect of Relative proficiency was not significant in the V-PP condition ($B = -0.0009$; $SE = 0.0008$; $t = -1.171$; $p = .249$).

In sum, for long passives, German–Dutch bilinguals showed significantly different listening patterns from the English–Dutch and monolingual children at critical segment 4 and spill-over segment 5. This was caused by the German–Dutch group slowing down in the PP-V condition at segment 4 and in the V-PP condition at segment 5 relative to the other two groups. The English–Dutch group showed similar behaviour to the Dutch monolinguals. The more dominant children were in German – as measured by Relative proficiency – the slower they became in the PP-V condition compared to the V-PP condition. No significant effects of language dominance were found in the English–Dutch group.

V2

Figure 2 shows children's average residual RTs in the V2 and V3 word orders (see Table S8 in the supplementary material for children's RTs and standard deviations). Again, the bilingual children had smaller residual RTs than the monolingual group, and the German–Dutch group was slightly faster than the English–Dutch group.

The main effect of Group was significant ($X^2 = 12.9$; $\Delta df = 2$; $p = .002$), whereas the 3-way interaction between Group, Word order and Segment was not ($X^2 = 4.6$; $\Delta df = 6$; $p = .602$). Summary effects showed that the monolingual children had significantly higher residual RTs than the English–Dutch ($B = 0.0256$; $SE = 0.0109$; $t = 2.351$; $p = .020$) and the German–Dutch bilinguals ($B = 0.0376$; $SE = 0.0106$; $t = 3.557$; $p < .001$; see

Table S9 in the supplementary materials for the model summary). The difference in residual RTs between the two bilingual groups was not significant ($B = 0.0120$; $SE = 0.0107$; $t = 1.114$; $p = .268$).

Language dominance

See Table 5 for the interactions between the three dominance measures, Word order and Segment for the English–Dutch and German–Dutch children. Only the 3-way interactions with Cumulative input and Relative proficiency in the German–Dutch group were significant (see Figure S10 in the supplementary material for the 3-way interaction with Relative proficiency).

At segments 2 and 4, effects of language dominance on children's RTs did not differ between word orders (Segment 2: Cumulative input: $B = 0.0003$; $SE = 0.0002$; $t = 1.723$; $p = .086$; Relative proficiency: $B = -0.0009$; $SE = 0.0005$; $t = -1.893$; $p = .059$; Segment 4: Cumulative input: $B < 0.0001$; $SE = 0.0002$; $t = 0.198$; $p = .843$; Relative proficiency: $B = -0.0003$; $SE = 0.0005$; $t = -0.589$; $p = .556$).

At segment 3, the greater children's relative exposure to and proficiency in German was, the slower they became in the V2 compared to the V3 condition, which was significant for Cumulative input ($B = -0.0005$; $SE = 0.0002$; $t = -2.429$; $p = .016$) and Relative proficiency ($B = 0.0011$; $SE = 0.0005$; $t = 2.256$; $p = .025$). The simple effect of language dominance was significant only in the V2 condition (Cumulative input: $B = 0.0007$; $SE = 0.0003$; $t = 2.106$; $p = .041$; Relative proficiency: $B = -0.0024$; $SE = 0.0008$; $t = -2.839$; $p = .007$) and not in the V3 condition (Cumulative input: $B = 0.0003$; $SE = 0.0004$; $t = 0.702$; $p = .487$; Relative proficiency: $B = -0.0013$; $SE = 0.0009$; $t = -1.432$; $p = .159$).

In summary, the monolingual and bilingual groups showed similar listening patterns in the V2 and V3 condition. Language dominance significantly influenced the listening patterns in the German–Dutch but not the English–Dutch group. The more German-dominant children were – as measured by Cumulative input and Relative proficiency – the more children slowed down in the V2 condition at critical segment 3.

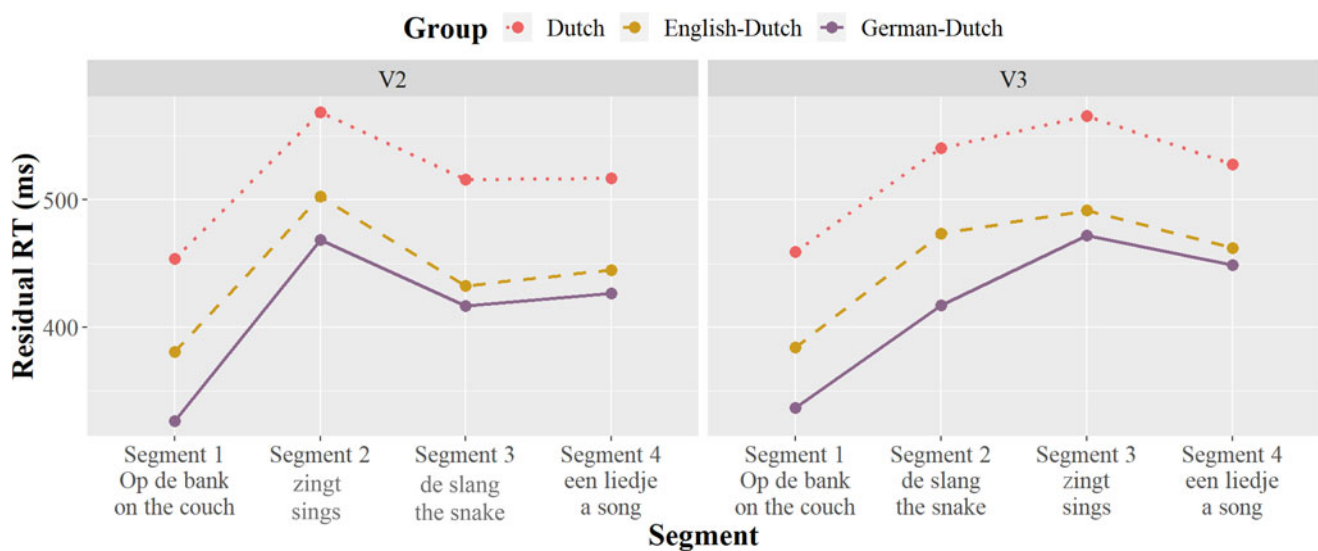
5. Discussion

This study investigated whether bilingual children show cross-linguistic influence in sentence processing and whether such influence is conditioned by language overlap and dominance. We hypothesized that structures in one of the children's languages activate overlapping structures in their other language resulting in slowdown effects during listening. Furthermore, we expected stronger cross-linguistic influence for partially overlapping structures compared to completely overlapping, and no cross-linguistic influence when language overlap was absent. We furthermore predicted stronger cross-linguistic influence in the form of inhibition the more English- or German-dominant children were.

The online behaviour of the German–Dutch bilingual children supported our hypotheses. First, German–Dutch children slowed down when listening to the partially overlapping PP-V structure in Dutch compared to the other two groups. Second, the more German-dominant children were, the stronger this slowdown effect became. Third, German–Dutch children also slowed down in the completely overlapping V2 structure, although only as a function of language dominance. Our findings are in line with previous studies showing that adult L2 learners are less efficient in processing their L2 when structures overlap with their L1 (e.g., Foucart & Frenck-Mestre, 2012; Hopp, 2017).

Table 4. Differences models after adding interactions between the three dominance measures, Word order and Segment by group for the long passive sentences.

		English-Dutch group			German-Dutch group		
		χ^2	Δdf	p	χ^2	Δdf	p
Current input	*Word order	0.2	1	.682	0.3	1	.595
	*Word order*Segment	4.4	2	.110	1.0	2	.613
Cumulative input	*Word order	0.1	1	.792	2.9	1	.090
	*Word order*Segment	2.4	2	.308	0.6	2	.746
Relative proficiency	*Word order	0.3	1	.556	8.4	1	.004
	*Word order*Segment	3.1	2	.211	0.2	2	.918

**Fig. 2.** Children's mean residual RTs in the V2 (top panel) and V3 (bottom panel) condition by group on segments 1, 2, 3 and 4.**Table 5.** Model differences after adding interactions between the three dominance measures, Word order and Segment by group for the V2/V3 sentences.

		English-Dutch group			German-Dutch group		
		χ^2	Δdf	P	χ^2	Δdf	p
Current input	*Word order	0.6	1	.433	2.3	1	.126
	*Word order*Segment	1.1	2	.572	3.3	2	.189
Cumulative input	*Word order	1.5	1	.224	2.3	1	.127
	*Word order*Segment	1.0	2	.615	9.4	2	.009
Relative proficiency	*Word order	0.7	1	.398	1.1	1	.288
	*Word order*Segment	0.2	2	.906	9.8	2	.007

5.1 Online cross-linguistic influence and language co-activation

Our results can be explained in terms of co-activation and inhibition. When German-Dutch bilingual children process Dutch PP-V and V2 structures, the same structures become activated in German (e.g., Hartsuiker & Bernelet, 2017; Hartsuiker et al., 2004; Nicoladis, 2006, 2012; Serratrice, 2016). Consequently,

activation spreads to German lemmas (e.g., Dell, 1986; Pickering & Branigan, 1998), increasing the overall co-activation of German. We assume that processing resources have to be allocated to inhibit this co-activation (e.g., Green, 1998; Green & Abutalebi, 2013), resulting in a temporal slowdown during Dutch sentence processing (see also Anderssen, Lundquist & Westergaard, 2018).

Cross-linguistic influence in previous offline studies with children has also been explained by syntactic co-activation during sentence processing (e.g., Nicoladis, 2012; Serratrice, 2016). Sentence structures in both bilingual children's languages compete for selection during production and comprehension. When a structure from the language not in use receives sufficient activation and is not inhibited sufficiently, it can be selected over a structure from the language in use and syntactic co-activation online becomes visible offline. In contrast, when inhibition is successful, online co-activation should not affect children's offline behaviour. This explains the absence of cross-linguistic influence in previous studies (e.g., Argyri & Sorace, 2007; Mykhaylyk & Ytterstad, 2017).

5.2 Language overlap

In line with this co-activation account of cross-linguistic influence, slowdowns in the German–Dutch children were clearest for the partially overlapping PP-V structure – in the group and dominance analyses – and less so for the completely overlapping V2 structure – only in the dominance analyses. The more frequent a structure in one of a bilinguals' two languages compared to the other, the more activation this language will receive. Such an unequal frequency distribution across languages is present in a situation of partial overlap: when the language being processed has more than one option for a certain morphosyntactic property and the language not in use has only one option (Runnqvist et al., 2013). This explains the more general slowdown effects for the partially overlapping PP-V structure compared to the completely overlapping V2 structure.

Our findings are in line with offline studies with bilingual children where cross-linguistic influence appeared in situations of partial overlap (e.g., Foroodi-Nejad & Paradis, 2009; Hulk & Müller, 2000). In complete and no overlap situations, offline cross-linguistic influence might still be possible, but co-activation is likely not strong enough to lead to visible effects in children's production or comprehension. Our findings for language overlap thus speak against a strong version of Hulk and Müller's (2000; Müller & Hulk, 2001) language overlap hypothesis: partial overlap is not a NECESSARY condition for cross-linguistic influence to occur online (van Dijk et al., 2021).

The hypotheses tested in this study partly stem from the sentence processing research in sequential bilingual adults (Foucart & Frenck-Mestre, 2012; Hopp, 2017; Runnqvist et al., 2013). To our knowledge, our study is the first to directly relate the construct of partial overlap from the field of child bilingualism to cross-linguistic influence in bilingual sentence processing. In doing so, we were able to explain why certain sentence structures in adult L2 processing might be more difficult to process than others (e.g., Foucart & Frenck-Mestre, 2012). Considering the adult bilingualism literature through the lens of the child bilingualism literature can thus help to better understand findings for bilingual adults.

5.3 Language dominance

Co-activation also explains our observation that slowdown effects during sentence processing became stronger with increased dominance in German. For the more German-dominant children German was more strongly co-activated, and this meant more processing resources were needed to inhibit German. This explains why listening times increased in the more German-dominant children for PP-V and V2 structures. Previous offline

studies with bilingual children also obtained stronger effects of cross-linguistic influence with increasing dominance in the language not in use (e.g., Bosch & Unsworth, 2020; Foroodi-Nejad & Paradis, 2009). Our online findings help to account for such offline findings.

Effects of dominance were most pronounced when dominance was operationalised as relative language proficiency, in line with studies with adult L2 learners (e.g., Alemán Bañón et al., 2018; Foucart & Frenck-Mestre, 2012; Hopp, 2017), where relative proficiency was also found to relate to patterns of cross-linguistic influence. We found similar trends for cumulative language exposure, but not for current input. It is unclear why. In general, the relationship between language dominance, exposure and proficiency is complex and subject to considerable discussion (e.g., Silva-Corvalán & Treffers-Daller, 2015; Unsworth et al., 2018). Further research is needed to explore these relations in detail.

5.4 Lexical overlap

Two observations were not in line with our hypotheses. First, there were no slowdown effects in the English–Dutch group, which we had predicted for the partially overlapping V-PP structure. The long passive structure may not be similar enough between Dutch and English to result in structural co-activation of the English V-PP order, due to differences in semantics (e.g., Verhagen, 1992). Online cross-linguistic influence would then not be expected. This explanation seems unlikely, however, as the passive structure can be primed between English and Dutch in sequential bilingual adults (e.g., Bernolet et al., 2009). Instead, we entertain an explanation in terms of lexical overlap, that is, the phonological similarity between English and Dutch was potentially insufficient to result in visible co-activation effects (Schepens, van der Slik & van Hout, 2013): of the 60 Dutch words in the critical segments, 30 were cognates with English compared with 43 for German,⁴ and the Dutch auxiliary *wordt* is furthermore similar in form and semantics to the German *wird* (cf. “is being” in English; e.g., Verhagen, 1992). Moreover, the morphological construction of past participles in Dutch is more similar to German than to English (compare *bitten* to Dutch *gebeten* and German *gebissen*).

Consequently, German may have been more strongly co-activated at the lexical level than English, resulting in more online lexical competition, on top of any structural competition. As a result, children had to spend more processing resources inhibiting German co-activation than English co-activation, which led to structural co-activation being visible in the German–Dutch and not the English–Dutch children. Note that on this explanation, structural co-activation of the V-PP order in English did occur, but was not strong enough to become visible in our task.

Our explanation is in line with Hopp (2017). He found that syntactic co-activation of the L1 only became visible in L2 processing when the overall L1 co-activation was strong enough – namely, in a bilingual mode, but not in a monolingual mode. Similarly, in our study syntactic co-activation resulted in slowdown effects during listening only when overall co-activation of children's other language was strong enough. Future studies with bilingual children should systematically manipulate lexical overlap to test this explanation.

Note, however, that our results cannot be explained by lexical overlap alone. If cognate-facilitation effects in German–Dutch

⁴Words were considered cognates when there were no more than two sound alternations between languages. For verbs, stems rather than inflected verbs were compared.

children were purely lexically driven, we should have observed such effects irrespective of structures tested. The German–Dutch group slowed down in the PP-V and V2 structures. Similarly, the observed effects of dominance should also have been equally strong for all four structures tested. Instead, we only observed significant effects of dominance in the PP-V and V2 word orders.

5.5 Parental input

A second unexpected finding was that German–Dutch children slowed down while listening to the V-PP structure at the spill-over segment. We did not expect such a slowdown effect, because – in theory at least – the V-PP structure does not overlap between Dutch and German (e.g., Betz, 2008; Dürscheid, 2012; Haider, 2010). However, AuxVO structures do sometimes appear in spontaneous speech, even though they are not part of the standard grammar (e.g., Betz, 2008; Dürscheid, 2012; Haider, 2010), so at least some of the German–Dutch children in our study may have been exposed to German V-PP structures. This is not unlikely, given that most German-speaking parents were L2 speakers of Dutch, possibly experiencing cross-linguistic influence from Dutch to German (e.g., Paradis & Navarro, 2003; Sorace, Serratrice, Filiaci & Baldo, 2009). Consequently, for some children, the German V-PP structure might have been an available structural representation. If true, the slowdown effect found in the German–Dutch children for the V-PP structure could be explained by structural co-activation during sentence processing.

Such an account fits nicely with Runnqvist et al.'s findings (2013). Faster online behaviour of the monolingual children in our study and the preferred production by adult Dutch native speakers of the V-PP structure (Bernolet et al., 2009) suggest that V-PP orders are more frequent than PP-V orders in Dutch. Runnqvist and colleagues found clear effects of online cross-linguistic influence from Mandarin only in the more frequent prenominal possessive structure in English. They argued that syntactic co-activation over time might only have been strong enough to show up in the already preferred prenominal structure and not in the less preferred postnominal structure. This could explain why we found a clear slowdown effect in the V-PP structure in Dutch, even though V-PP is not the canonical word order in German. Future studies are necessary to further investigate the role of partial overlap online, making sure that the 'non-overlapping' order is truly unavailable in one of the languages of the bilingual child, such as Adj-N and N-Adj orders in French and English (e.g., Foucart & Frenck-Mestre, 2012).

6. Conclusions

Our study is among the first to investigate cross-linguistic influence in bilingual children's listening times during real-time sentence processing and the first to use the self-paced listening paradigm for this goal. Online cross-linguistic influence was manifested as inhibition during listening when structures were shared between languages. Crucially, cross-linguistic influence was modulated by structural overlap and language dominance, and possibly also by lexical overlap. Cross-linguistic influence was only attested from German to Dutch, two highly related languages in terms of lexical overlap, and not from English to Dutch. It was more visible in a situation of partial overlap than in a situation of complete overlap, and it became stronger the more dominant children were in German. We argued that these three factors

affected the amount of language co-activation during sentence processing and concomitantly the level of inhibition needed to process a unilingual sentence. It was only when sufficient co-activation was present that inhibition became visible in children's listening times.

In conclusion, the use of an online research technique allowed us to reveal subtle effects of cross-linguistic influence on listening times during real-time sentence processing in bilingual children. We believe that online studies like this one are crucial to develop a more comprehensive account of cross-linguistic influence in bilingual language development and a better understanding of the processing mechanisms that underpin it.

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Supplementary Material. For supplementary material accompanying this paper, visit <https://doi.org/10.1017/S1366728922000050>

Table S1. Full list of experimental items with long passive structure used in self-paced listening task.

Table S2. Full list of experimental items with verb second and verb third structure used in self-paced listening task.

Table S3. Children's mean RTs and SDs (in ms) on the self-paced listening task per segment in the PP-V and V-PP condition.

Figure S4. Dutch monolingual (left panel), English–Dutch bilingual (middle panel) and German–Dutch bilingual children's (right panel) mean residual RTs in the PP-V and V-PP condition on segments 2, 3, 4, and 5.

Table S5. Summary of the mixed linear model of English–Dutch, German–Dutch and monolingual Dutch children's residual RTs on the long passive sentences at segment 4.

Table S6. Summary of the mixed linear model of English–Dutch, German–Dutch and monolingual Dutch children's residual RTs on the long passive sentences at segment 5.

Figure S7. Average estimated marginal means of Relative proficiency in interaction with the PP-V and V-PP word orders on segments 3, 4 and 5 in the German–Dutch group. A negative relative proficiency score reflects a higher score on the German than on the Dutch sentence repetition task.

Table S8. Children's mean RTs and SDs (in ms) on the self-paced listening task per segment in the V2 and V3 condition for each group.

Table S9. Summary of the mixed linear model of English–Dutch, German–Dutch and monolingual Dutch children's residual RTs on the V2/V3 sentences.

Figure S10. Average estimated marginal means of the interaction between Relative proficiency and the V2 and V3 word orders on segments 3, 4 and 5 in the German–Dutch group. A negative relative proficiency score reflects a higher score on the German than on the Dutch sentence repetition task.

Competing interests. The authors declare none.

Data availability. The data that support the findings of this study are openly available in OSF at <https://osf.io/6z3dp/>.

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