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STRUCTURAL REPRESENTATIONS IN LATE LEARNERS OF A SECOND LANGUAGE: EFFECTS OF L2 PROFIENCY AND INTERVENTION METHODS

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TO LEV MAHORO

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CHAPTER 1

INTRODUCTION

When learning a second language (L2), learners can sometimes rely on their first language (L1) syntactic knowledge to form an L2 syntactic structure if the structure is similar between the L1 and L2. For example, French-speaking learners of Dutch may use their knowledge of French to form a passive sentence because this structure is similar in both languages ("*Le garçon <u>est embrassé par la fille</u>*" – "*De jongen wordt <u>gekust door het meisje</u>*" [The boy is being kissed by the girl]). In this passive form, the prepositional by-phrase occurs in the sentence final position. An L2 may, however, also have syntactic structures that do not occur in the learner's L1 at all. For instance, unlike French, there exist another way of formulating a passive form in Dutch, namely, "*De jongen wordt <u>door het meisje gekust</u>*", which does not exist in French (**Le garçon est par la fille embrassé*) [*The boy is by the girl being kissed]). Here, the prepositional by-phrase occurs in the sentence medial position. For these dissimilar L2 syntactic structures, the learner cannot depend on their L1 syntactic knowledge in the initial stages of L2 syntactic acquisition because there is no similar L1 structure available to them (Hartsuiker & Bernolet, 2017). Hence, for these dissimilar L2 structures, second language learners need to develop and establish structural representations.

But how does this late learning of similar and dissimilar L2 syntactic structures occur, and when do late learners establish structural representations of these structures ready for production? Moreover, what role does L2 proficiency play in the formation of abstract structural representations for similar and dissimilar L2 structures in the L2 and between the first and second language? Lastly, dissimilar L2 syntactic structures may not be spontaneously produced if a similar L2 syntactic structure is available to the L2 learner. Can increased structural repetition of dissimilar L2 syntactic structures and a few instances of verb overlap function as intervention tools to boost the production of these structures? In this dissertation, I use the *structural priming* paradigm (Bock, 1986) to answer these questions.

Structural Priming: A Robust Paradigm

Human beings have an exceptional competence to produce spoken language[1]. During spoken language production, there are different syntactic structures that people can use. However, despite the richness that language offers us, people tend to repeat the same syntactic structures that they have either recently produced themselves or have heard from their conversational partners. In this dissertation, this form of repetition in language is referred to as *structural priming* (Bock, 1986). Structural priming refers to the phenomenon where the processing of a syntactic structure is facilitated by previous exposure to the same structure. To investigate structural priming in spoken language, researchers often use comprehension-production tasks. In these tasks, participants usually first listen to a syntactic structure that describes an action (e.g., a passive sentence: “The woman is being licked by the dog”); this is referred to as the *prime* sentence. Then after this, participants are asked to conjugate a transitive verb and use that for the description of the target picture, which usually directly follows the prime sentence (i.e., there are no intervening sentences between the prime and target sentences[2]). Here, participants will show a stronger tendency to produce a passive

[1] In this dissertation, I only focus on spoken language and not on other modalities of language production (e.g., written language, sign language). A comprehensive overview on language production can be found in Goldrick et al. (2014).

[2] In some experiments, researchers choose to manipulate the number of sentences between the prime and target sentences (see e.g., work by Hartsuiker et al., 2008; Bernolet et al., 2016). In my experiments, there were no intervening sentences between the prime and target sentences. However, in most of my experiments, a verification task was inserted after hearing the prime sentence, after which participants formulated the target sentence.

target sentence (e.g., “The girl is being kissed by the boy”) than to produce its active counterpart (“The boy kisses the girl”). This is because they have just heard the same syntactic structure in the previous utterance. Initial experimental investigations into structural priming tested native speakers of English (Bock, 1986; Bock, 1989; see Branigan et al., 1995 for a discussion), and this allowed researchers to study the extent to which structural priming takes place under varying conditions. As such, structural priming has been investigated in different types of (sentence) structures (e.g., ditransitives [prepositional object datives vs. direct object datives] in Bock & Loebell, 1990; noun-phrase structures in Cleland & Pickering, 2003; particle placement in Konopka & Bock, 2005; see also Griffin & Weinstein-Tull, 2003), and in different modalities (in written language production: Pickering & Branigan, 1998; Corley & Scheepers, 2002; and in language comprehension: e.g., Ledoux et al., 2007). Moreover, researchers have investigated structural priming in other languages than English (e.g., Dutch: Hartsuiker & Kolk, 1998; German: Scheepers, 2003). Mahowald et al. (2016) provided an extensive meta-analysis on structural priming in language production, starting from the work by Bock (1986) up until 2013.

In this dissertation, I used structural priming to investigate how late second language (L2) learners establish and access structural representations in their L2 and use these during production. I specifically focused on the effects of L2 proficiency on structural priming in the L2 and between the L1-L2, and on whether structural priming can be used as an intervention tool to boost the production of less preferred L2 syntactic structures in late L2 learners. I elaborate on this later in the text.

Three Theoretical Accounts to Structural Priming

Three theoretical accounts have been crucial to our understanding of the mechanisms that could explain structural priming effects during language production: (1) a lexicalist account

(Pickering & Branigan, 1998; Hartsuiker et al., 2004), (2) an implicit learning account (Chang et al., 2000; Chang et al., 2006), and (3) a multifactorial account that combines different aspects of the lexicalist and implicit learning accounts (Bock & Griffin, 2000; Hartsuiker et al., 2008; Reitter et al., 2011).

A Lexicalist Account to Structural Priming: The Residual Activation Theory

The starting point for lexicalist explanations of structural priming is the idea that lexical and syntactic information are stored in a network of representational nodes (see Levelt et al., 1989; Roelofs, 1992). In the speech production model of Levelt et al., words are represented and activated at a conceptual level, with activation subsequently spreading to a lemma stratum representing linguistic categories (e.g., whether a lemma is a verb, a noun…) and potential syntactic structures or combinatorial nodes (i.e., the syntactic structures in which a verb can occur, such as an active or a passive structure). Then finally, activation spreads to the word-form stratum, where phonological and morphological information is activated to generate the speech sounds that are necessary for the output. In their residual activation theory, Pickering and Branigan (1998) adopt Levelt et al.'s model to illustrate the mechanism that may be responsible for structural priming effects. That is, Pickering and Branigan propose that the lemma stratum comprises a set of lemma nodes holding lexical information, which are linked to combinatorial nodes holding syntactic information. During syntactic comprehension, activation spreads through the network of nodes, and the most highly activated lemma is chosen during the lexical selection stage (Pickering & Branigan, 1998). Consequently, the spreading of activation results in short-term activation of the selected lemma which is connected to its corresponding combinatorial nodes. Concretely, if a speaker has recently comprehended the sentence "The woman is being licked by the dog", this leads to short-term activation of the lemma node for "lick", and the combinatorial node for the passive structure in which “lick” occurs. Importantly, the link between the lemma node and the combinatorial node is strengthened when both nodes are activated. If the speaker’s next utterance requires the use of either an active or a passive sentence, they[3] will be more likely to reuse a passive sentence for the description, because the corresponding nodes retain activation which incites the speaker to use the same syntactic structure, even when encountering a different verb (e.g., “to kiss” in the sentence “The girl is being kissed by the boy”). However, when the prime and target sentences share a verb (e.g., “The mother is being *licked* by the baby”), the speaker will have a stronger tendency to repeat the same syntactic structure (a passive). This happens because the link between the lemma and combinatorial node is strengthened to an even greater degree, resulting in more activation spreading to the combinatorial node. This phenomenon is known as the *lexical boost effect* to structural priming (Pickering & Branigan, 1998). Studies have demonstrated that lexically dependent and lexically independent structural priming are short-lived when the prime and target sentences do not immediately follow each other (i.e., when there are intervening sentences between the prime and target sentences) (Bernolet et al., 2016). “Short-lived” means that the activation in the corresponding lexical and combinatorial nodes of the prime sentence structure quickly diminishes, such that the odds for structural repetition becomes smaller. According to Bernolet et al. (2016), the lexical boost, as proposed by Pickering and Branigan, is an example of a very strong overlap between prime and target sentences in which the main verb has the exact form and meaning, such that this results in a strong boost for structural repetition. This is demonstrated in Bernolet et al. (2014), who found a stronger structural priming effect when dative verbs were used in the same sense than when they were used in different senses. That is, in the following two sentences, “to give” means “to deliver” and it

[3] In this dissertation, I use the gender neutral ‘they’ to refer to a previously mentioned singular subject.

has the same form in both sentences: “The cook gives the sailor a hat” – “The nun gives the soldier a book”. In contrast, in the following sentences, “to give” has the same form, but it does not have the same meaning, as it means “to cause an effect” in the second sentence: “The boxer gives the sailor a cake” vs. “The judge gives the cook a heart attack”. Bernolet et al. (2016) propose that any similarity between the prime and target sentences, be it on the lexical, semantic, or phonological level, can increase the likelihood that the same syntactic structure will be repeated for the formulation of the target structure. If there is more overlap between the prime and target sentences (in form but also in meaning), the more likely it is that a speaker will reuse the prime structure to produce the target structure.

Though the residual activation theory provides an explanation for structural priming effects in immediate conditions and for the lexical boost effect, this theory cannot explain long-term priming effects. Several studies observed abstract structural priming (e.g., priming without lexical overlap) when sentences intervene between the prime and target sentences (Bock & Griffin, 2000; Hartsuiker et al., 2008; Konopka & Bock, 2005; Branigan & McLean, 2016). The results from these studies imply that abstract structural priming effects linger on for a longer time course, compared to the lexical boost effect, and may therefore rely on a different mechanism than residual activation in lexical and combinatorial nodes.

In sum, lexicalist accounts, such as the residual activation theory, are activation based, and as such, structural priming effects are expected to disappear after other sentences intervene between the prime and target sentences. Moreover, because lemmas play an important role during the selection of syntactic structures, the processes responsible for structural priming take place within the mental lexicon (Hartsuiker et al., 2008).

Structural Priming as a Form of Implicit Learning

In contrast to the residual activation account, the implicit learning account (Bock & Griffin, 2000; Chang et al., 2000; Chang et al. 2006) proposes that structural priming effects result from long-term implicit learning processes. Specifically, Chang et al. (2006) suggest that structural priming occurs through a learning mechanism that involves making predictions about the next word in a sentence and adjusting the connection weights of a given structure based on errors encountered during syntactic processing. In other words, this error-based learning mechanism makes use of an *incremental* processing system (Chang et al., 2006). Implicit learning occurs due to changes in the strength of the connection weights of a given syntactic structure. For instance, when a speaker experiences a passive sentence, while they expected an active sentence (because the active is the most frequent transitive alternant), the mechanism will signal an error when the language user has processed the passive verb form (e.g., an error will most likely occur after the verbs *is being followed* [The pirate is being followed by the boxer]). Because of this, changes will occur in the weights responsible for the abstract representation for the passive structure since the learning mechanism failed to predict the sentence. Syntactic learning happens because people experience a mismatch between syntactic predictions and the syntactic structures they actually encounter during processing. The stronger the prediction error during syntactic processing, the larger the changes to the weights of a given syntactic structure. As such, less frequent structures (e.g., passives) induce a larger prediction error than more frequent structures (e.g., actives). This gives rise to stronger priming for less frequent structures, than for more frequent ones, a phenomenon that has been coined the *inverse-frequency* effect to structural priming (Hartsuiker & Westenberg, 2000; Jaeger & Snider, 2013). Upon each encounter of a specific structure, the weights of this structure will be strengthened, which increases the likelihood of the same structure being used in a following utterance. Chang et al. assume that the weight changes are permanent, and according to this assumption, abstract structural priming persists over a longer time. Indeed, abstract structural priming has been found to persist even when other sentences intervene between the prime and target sentences (see e.g., Bock & Griffin, 2000; Hartsuiker et al., 2008, and Gries, 2005, who showed long-term structural priming in a corpus consisting of natural language). The lexical boost effect to structural priming, as proposed by Pickering and Branigan (1998), cannot be explained by the implicit learning account. According to Chang et al., the lexical boost effect is not rooted in the weight-changes mechanism. Instead, they argue that the repeated verb in the target sentence acts as an explicit cue to the memory of the prime sentence, which, in turn, incites speakers to reuse the previously comprehended syntactic structure. Put differently, Chang et al. (2006) use an explicit learning mechanism to explain the lexical boost effect to structural priming.

Altogether, according to the implicit learning account, structural priming is considered as a form of implicit learning, such that less frequent syntactic alternants induce stronger priming effects than more frequent ones. Moreover, implicit learning is assumed to only affect abstract syntactic processes, and as such, the processes responsible for structural priming occur outside the mental lexicon (see Chang et al., 2006; Hartsuiker et al., 2008).

A Multifactorial Account to Structural Priming

The previous discussion on the lexicalist and the implicit learning account demonstrates that neither mechanism can explain the complete range of structural priming effects. Therefore, a multifactorial account of structural priming has been suggested, where abstract structural priming results from long-term learning processes, as proposed in the implicit learning account, and where lexically dependent immediate priming is caused by a short-term mechanism, such as residual activation in representational nodes (Hartsuiker et al., 2008). Such a multifactorial account was already proposed by Bock and Griffin (2000) and by

Chang et al. (2006). In brief, these authors hypothesized that structural priming occurs partly due to an implicit learning mechanism, and partly due to a mechanism that utilizes the explicit memory of the prime sentence to increase the odds of repeating the prime structure for the formulation of the target structure. Here, lexical overlap functions as a strong memory cue to repeat the previously comprehended syntactic structure.

Reitter et al. (2011) used a computational model to test the hypothesis that structural priming can be best explained by a multifactorial account. According to Reitter et al., activation of lexical and syntactic information is determined by two important mechanisms: the *base-level* activation of syntactic information and *spreading* activation from lexical information to syntactic information. Due to implicit learning processes, highly frequent structures have a higher base-level activation than structures that occur less frequently. Because of this higher base-level activation, less learning occurs for higher frequency structures. As such, stronger priming will occur for less frequent syntactic structures (because more learning takes place) than for more frequent ones, which explains the inverse-frequency effect (Jaeger & Snider, 2013). This is similar to the assumption that more learning occurs for less frequent structures (Chang et al., 2006). The second aspect of the model of Reitter et al. suggests that structural priming is a result of lexical activation that spreads from working memory to longer-term memory. That is, during production, the lexical information that is represented in working memory acts as a cue to retrieve syntactic information, which explains enhancements of structural priming, such as the lexical boost effect (Pickering & Branigan, 1998). Note, however, that Reitter et al. do not limit the lexical boost effect to the repetition of lexical heads like Pickering and Branigan. Instead, Reitter et al. propose that priming should be boosted by any type of lexical overlap between the prime and the target. Thus, the hybrid model combines aspects of implicit learning accounts (base-level activation) and lexicalist accounts (spreading activation) that can explain a wider range of structural priming effects.

It is important to point out that the above discussed theoretical accounts aiming to explain structural priming apply to syntactic processes in *monolinguals*. However, at the beginning of this century, researchers started to address structural priming in bilingual speakers (Loebell & Bock, 2003; Hartsuiker et al., 2004). An important question was to investigate how structural representations are represented in the bilingual mind. Concretely, researchers wondered whether L2 syntactic representations are stored separately or together with L1 structural representations. I turn to these bilingual structural priming studies in the section below.

Structural Priming in Bilingual Speakers

Previous work on language transfer (e.g., Selinker & Gass, 1992) and codeswitching (Myers-Scotton, 1993) suggests that both languages of a bilingual are simultaneously active during language production. This may imply that (1) syntactic structures between languages are stored together in a shared lexical-syntactic network. Alternatively, it may imply that (2) syntactic structures between languages are simultaneously active in their separate lexical-syntactic networks. If it were the case that bilinguals share a lexical-syntactic network, one can imagine that priming may occur for sentence structures that are *similar* between the languages of a bilingual. For instance, upon hearing a prepositional object dative (a PO) in Dutch, a Dutch-English bilingual may reuse their PO representation in Dutch to formulate the same structure in English since both structures are similar in both languages. Thus, in the sentence "*De man geeft het boek aan de vrouw"* (The man gives the book to the woman) in Dutch, the bilingual may use the same structure to formulate the English sentence. In contrast, if bilinguals were to have a separate lexical-syntactic network for the L1 and the L2, one would not predict the same structural repetition in the bilingual's L2. Importantly, research on structural priming in bilingual individuals has provided strong evidence to support the idea that bilinguals have a shared lexical-syntactic network for syntactic representations that are *sufficiently similar* between the two languages they speak (e.g., Loebell & Bock, 2003; Hartsuiker et al., 2004; Cai, Pickering, Yan, & Branigan, 2011). Hartsuiker et al. (2004) demonstrated that participants had a stronger tendency to produce English passive sentences (The ship is destroyed <u>by the torpedo</u>) after they heard a Spanish passive prime sentence ("*El camión es perseguido por el taxi*" [The truck is chased by the taxi]), than when they heard a Spanish active prime sentence. Building on the predictions of the residual activation account (Pickering & Branigan, 1998), Hartsuiker et al. suggested that, in bilinguals, the activation of lexical and syntactic representations in one language induces activation of translation equivalents (see e.g., Schoonbaert et al., 2007; Cai et al., 2011) and shared structures in the other language. Consequently, *cross-language/cross-linguistic* structural priming occurred between the Spanish passive form and English passive form due to their shared syntactic representation (see also Shin & Christianson, 2009; Salamoura & Williams, 2007; Bernolet et al., 2013; Favier et al., 2019; Kootstra & Muysken, 2017; see Van Gompel & Arai, 2018, for a review on cross-language priming).

Throughout this dissertation, three terms will be frequently used to describe how and to what extent L2 syntactic structures are represented in bilinguals: "similar", "shared" and "dissimilar". In this context, "sharing" refers to bilingual individuals representing a given syntactic rule that is similar in both of their languages only once in memory. Consequently, "similar" refers to comparable word orders in different languages, which allows the merging of corresponding syntactic representations into one shared representation. In other words, if syntactic structures are sufficiently similar at the surface level in two languages, there is one shared syntactic representation for these structures in the bilingual's memory (illustrated above with the Spanish passive form and the English passive form in the work by Hartsuiker et al., 2004). By using the term “similar”, I do not imply that the emergence of a shared syntactic representation in bilinguals solely relies on similar word order between syntactic structures. Several studies have shown that word order differences in syntactic structures do not impede cross-language structural priming to take place. For instance, Muylle et al. (2020b) found that active SVO (subject-verb-object) structures in Dutch were shared to the same extent with active SVO and active SOV (subject-object-verb) structures in an artificial language, suggesting that word order differences do not affect the occurrence of cross-language structural priming. Additionally, Bernolet et al. (2009) found priming between two passive forms that differ in the order of the past participle and the prepositional phrase, namely Dutch PP-medial passives (*De hond wordt door de kat achtervolgd* – [*The dog is by the cat being followed]) and English PP-final passives (*De hond wordt achtervolgd door de kat* - [The dog is being followed by the cat]). The authors attributed this priming effect to a *shared information* structure. This means that at a higher level, the patient (the dog), which is the grammatical subject, is emphasized in both passive forms. Cross-language structural priming has also been found between German PP-medial passives and English PP-final passives in comprehension (Weber & Indefrey, 2009; see Chen et al., 2013; Hwang et al., 2018; Shin & Christianson, 2009, who found cross-language structural priming using sentences with different word orders).

Crucially, syntactic structures may have similar word orders at the surface level, but there may be differences at a deeper level, such as the morphosyntactic level, that can hamper the merging of syntactic representations into one representation. Put differently, slight differences in the morphosyntactic realization of syntactic structures may hinder the sharing of syntactic representations. For instance, the Dutch S-genitive and the English S-genitive differ in their morphosyntactic realization (e.g., “het meisje haar bal” vs. “the girl’s ball”). In Dutch, a possessive pronoun is used (*haar* - her) to denote the object (“haar bal”), whereas in

English, the possessive morpheme – ‘s is used (“the girl’s ball”). Nevertheless, Bernolet et al. (2013) found cross-language priming between Dutch and English S-genitives upon increasing L2 proficiency, suggesting that, despite the morphosyntactic differences, a shared representation was established. Following the example in Bernolet et al., in this dissertation, the term “dissimilar” is used (1) to denote sentence structures that appear to be similar at the surface level but are morphosyntactically different from each other, which may hamper the formation of a shared syntactic representation. Moreover, “dissimilar” can also refer (2) to sentences that have a completely different word order in the L1 compared to the L2, such as the passive forms in French and Dutch. French and Dutch share the passive which places the prepositional by-phrase at the end of the sentence, referred to as the PP-final passive structure, (“*Le home <u>est suivi par le chien</u>*” - “*De man <u>wordt gevolgd door de hond</u>*” [The man is being followed by the dog]). However, the Dutch passive form which places the prepositional by-phrase in the middle of the sentence does not exist in French and is thus dissimilar from the PP-final passive in French: *De man <u>wordt door</u> de hond gevolgd”* and “*Le home <u>est suivi par le chien</u>*” are dissimilar.

As discussed, structural priming has proven to be useful to investigate whether similar L1-L2 syntactic structures are shared in bilinguals (Van Gompel & Arai, 2018), and we believe that it is particularly useful to investigate to what extent learners have developed a syntactic representation for *dissimilar* L2 structures. This is because L2 learners may not spontaneously produce dissimilar (and perhaps less frequent) L2 structures if there is a similar syntactic alternant available to them. This would suggest that L2 learners do not have syntactic representations for dissimilar L2 structures. In this case, using structural priming may incite learners to produce dissimilar structures, and if priming does happen, this means that learners have developed a mental representation for both similar and dissimilar L2 structures, which they can use during L2 syntactic production (Pickering & Ferreira, 2008).

So far, bilingual theories that explain cross-linguistic structural priming are rooted in a lexicalist account in which lexical, syntactic, and language nodes retain activation which prompts speakers to reuse the same syntactic structure in the target language (Hartsuiker et al., 2004; Hartsuiker & Bernolet, 2017). However, recently, Khoe et al. (2021) implemented and tested a bilingual version of the implicit learning account, and they showed that error-based learning plays an important role in L2 learning. Importantly, they demonstrated that cross-language priming occurred between structures with different word orders, which is in line with the results of several studies (see e.g., Bernolet et al., 2009; Muylle et al. 2020b). Nevertheless, Khoe et al.'s model does not make any statements as to whether the lexical boost effect to structural priming is due to an explicit memory mechanism (similar to Chang et al., 2006). Though a hybrid model (Reitter et al., 2011) seems to better explain a wider range of structural priming effects in the L1 than the lexicalist and the implicit learning account, such a hybrid model predicts that within-language priming will only occur between sentences with the same word order, since the surface order in which phrases appear are computed in a single step. Their claim is compatible with the results in Pickering et al. (2002), who found that a so-called *shifted* construction, in which the prepositional phrase precedes the noun phrase ("The racing driver showed <u>to the mechanic</u> the extremely dirty and badly torn overall"), did not prime a PO construction ("The racing driver showed the extremely dirty and badly torn overall <u>to the mechanic</u>"). This finding suggests that word order plays an important role for priming to occur. Since the model of Reitter et al. does not allow within-language priming to take place between structures with different word orders, it also does not predict priming to occur between languages, though the model has never been applied to cross-language priming. However, as mentioned before, several studies have already reported that cross-language priming between structures with different word orders takes place (see Muylle et al., 2020b).

In the following section, I discuss Hartsuiker and Bernolet's (2017) developmental account of L2 syntactic acquisition, which is an activation-based account. The account aims to explain how L2 syntactic representations are developed from the earliest stages up until the L2 learner has reached a high enough proficiency such that similar L1-L2 syntactic structures become shared.

Hartsuiker and Bernolet's (2017) developmental account of L2 syntactic acquisition

Building on the assumption that sufficiently similar syntactic structures are shared between languages (Hartsuiker et al., 2004), Hartsuiker and Bernolet (2017) proposed their developmental account for the acquisition of L2 syntax. According to this account, second language learners form representations of L2 syntax in five different stages (see Figure 1). The account was constructed based on the observation that abstract priming (structural priming without lexical overlap) within the L1 and between the L1-L2 became stronger upon increasing L2 proficiency, in contrast to item-specific priming (structural priming with lexical overlap) within the L2, which was stronger in lower proficiency L2 speakers than in higher proficiency L2 speakers (see Bernolet et al., 2013; and a reanalysis of Schoonbaert et al. [2007] by Hartsuiker & Bernolet [2017]). This suggests that L2 syntactic acquisition starts with item-specific representations that gradually evolve into abstract syntactic representations, and eventually, these L2 abstract syntactic representations become shared with existing similar L1 syntactic representations (i.e., the "end-stage[4]" of L2 syntactic acquisition where cross-language priming may be observed). The upper-panel in Figure 1 depicts a fully acquired L1 lexical-syntactic network. The panel below presents the process of

[4]An "end-stage" implies that an L2 learner has reached an end point in their L2 syntactic acquisition in which similar L1-L2 syntactic structures are completely shared, such that additional learning may no longer take place. However, the term "end-stage" should be interpreted with some nuance since learning of structural biases in the L2 can still take place (see Chapter 5 where short-term learning can shifts explicitly learned structural preferences in the L2).

L2 lexical-syntactic acquisition, in which, at the end-stage, similar L2 syntactic representation become shared with existing L1 syntactic representations.

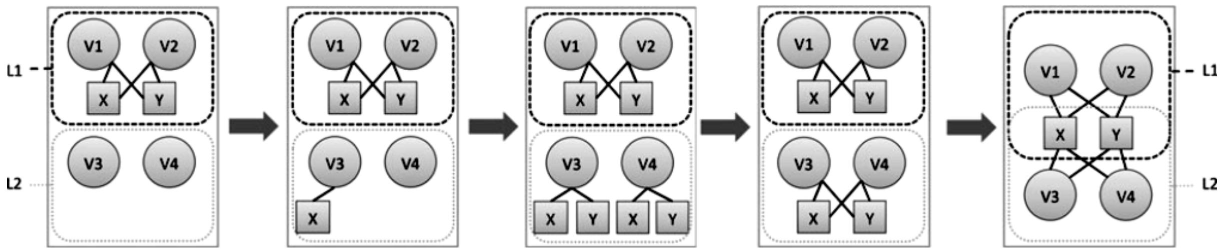

Figure 1 Developmental model for L2 syntax acquisition as proposed by Hartsuiker and Bernolet (2017). V1, V2 etc. are lexical representations. X and Y are syntactic representations.

Stage 1. In the beginning of L2 syntactic acquisition, the learner (e.g., a Dutch-English bilingual) only has lexical representations without syntactic information connected to them (left most panel with separate lexical representations, depicted as V3 and V4). For instance, a Dutch-English bilingual may only have lexical representations for the ditransitive verbs “give” and “sell”, while in their L1, the lemma node for “geven” (give) and “verkopen” (sell) are connected to the combinatorial nodes for the direct object dative (DO: *De man verkoopt de vrouw de bloemen* - “The man gives the woman the flowers”) and the prepositional object dative (PO: *De man geeft de bloemen aan de vrouw* - “The man gives the flowers to the woman”). There are two strategies that the bilingual can apply to formulate an L2 syntactic structure with the ditransitive verb “give”. (1) The learner can use their L1 syntactic knowledge to formulate sentences in the L2, which can sometimes be successful if the similar L1 verb takes the same syntactic structure (e.g., using a PO construction for the verb “give”: *De man geeft de bloemen aan de vrouw* – “The man gives the flowers to the woman”). However, sometimes, using the L1 syntactic knowledge can lead to transfer errors in the L2 (e.g., “*I give Sunday a party”). In this example, the sentence contains a word order error from the L1 (“Ik geef zondag een feestje”, and the verb “give” is erroneously used (correct: “I am having a party on Sunday”). It is believed that L1 transfer indeed happens in the very beginning stages of L2 acquisition (see e.g., Schwartz & Sprouse, 1996, Full Transfer Full Access/FTFA model). Next to L1 transfer onto L2 production, (2) L2 learners can use a copy-edit strategy when conversing with more proficient L2 speakers. Here, the less proficient L2 speaker can use the explicit memory of syntactic structures as a cue to retrieve a similar structure from working memory (Bernolet et al., 2016). Hartsuiker and Bernolet predict that, in this first stage of acquisition, beginning L2 learners will probably only show priming within the L2 when the prime and target sentence share the same lexical verb and when the prime-target pair immediately follow each other (Bernolet et al., 2016).

Stage 2. In the next stage, the L2 learner will have already formed an item-specific syntactic representation for a particular lexical item. For instance, to formulate a PO construction, the Dutch-English bilingual may now know that the lexical verb “give” should be followed by a noun phrase (NP) and a prepositional to-phrase (to-PP) (“The man gives the flowers [NP] to the woman [to-PP]”). However, the learner may not yet realize that this rule applies to other ditransitive verbs too, such as “sell”. Importantly, during this stage, it is likely that the L2 learner will first learn that “give” can appear in a PO construction, before they learn that it can also appear in a DO construction. This is because the PO construction occurs more frequently in English than the DO construction (a recent study from Van Lieburg [under review] reports a PO bias in native English speakers[5]. Moreover, Corley and Scheepers [2002] also report a PO bias in native speakers of English). In other words,

[5] However, Bock and Griffin (2000) report that native English speakers have a DO preference, thus implying that this structure is more frequently used than the PO construction.

beginning L2 learners are likely to first form syntactic representations for more frequent structures than for less frequent ones. This implies that, during this stage, within L2 priming may be found for frequent structures (e.g., POs, actives), but not yet for infrequent ones (e.g., DOs, passives).

Stage 3. With increasing L2 exposure, the learner becomes more proficient at their new language, and they develop more item-specific syntactic representations (central panel in Figure 1). As a consequence of this, the learner can now use other ditransitive verbs to formulate a PO construction and the less frequent DO construction. That is, the learner can formulate the sentence “The woman sells the toys to the child”, and the sentence “The woman sells the child the toys”. However, the learner may have not yet generalized the abstract rule to formulate a PO or a DO construction with other verbs, and as such, the learner still has item-specific syntactic representations. This means that the lexical representation for the verb “give” is linked to its individual combinatorial PO and DO nodes, and the same goes for the lexical representation for the verb “sell”. Hartsuiker and Bernolet propose that, during this stage and the previous stage, lexical overlap is still necessary to induce structural priming since the representations are item-specific. Thus, at this stage, there is no abstract priming within the L2 yet. Unlike the first stage, where explicit memory of the prime sentence is crucial for priming to occur, Hartsuiker and Bernolet suggest that, during Stages 2 and 3, the prime and target sentences do not need to immediately follow each other. This is because priming effects are now caused by residual activation of specific lexical nodes together with their corresponding combinatorial nodes (Bernolet & Hartsuiker, 2018). It is important to note that Hartsuiker and Bernolet do *not* imply that explicit memory processes stop playing a role during Stages 2 and 3. Instead, they propose that other mechanisms, such as residual activation, may *additionally* induce structural priming effects. The learner is no longer solely dependent on their explicit memory, but the explicit memory of the prime sentence can still boost the production of a target structure in the L2 during these two stages, which results in stronger priming in immediate conditions (Bernolet & Hartsuiker, 2018).

Stage 4. During this stage, the learner starts forming abstract syntactic representations across verbs within the L2. The learner has become more proficient and has now learned that the same syntactic structures (e.g., a PO and a DO) can be used across different verbs (e.g., “give” and “sell”). Because of this, the learner will now show abstract structural priming within the L2. Here, priming is caused by the residual activation of abstract syntactic representations (Bernolet & Hartsuiker, 2018). The abstraction process first takes place for more frequent structures than for less frequent ones. Importantly, Hartsuiker and Bernolet assume that the abstraction process of L2 syntactic representations occurs independently from abstract L1 syntactic representations. This implies that the learner may have separate syntactic representations for L1 and L2 constructions, even if these structures are very similar in both languages (i.e., the learner has L1 syntactic representations for the PO and DO, and they have separate L2 syntactic representations for the same structures). This suggests that, during this stage, the syntactic representations are still language-specific. Therefore, cross-linguistic priming does not occur yet.

Stage 5. When this stage has been reached, syntactic structures that are sufficiently similar between languages become shared across languages. The learner will now show cross-linguistic priming between similar L1-L2 syntactic structures (with and without verb overlap), as their corresponding syntactic representations are merged into one syntactic representation.

Important implications from the developmental account are that the merging of similar L1 and L2 syntactic representations into one shared syntactic representation occurs earlier for frequent L2 syntactic alternants than for less frequent ones. For instance, a Dutch-English bilingual will establish a shared syntactic representation for the active structure sooner than for the passive structure. Moreover, the predictions of the developmental account, especially concerning the end stages of lexical-syntactic acquisition, were based on L2 learning data of quite proficient L2 speakers (Bernolet et al., 2013). However, no such data were available to support the predictions of the earliest stages of L2 lexical-syntactic acquisition. Instead, Hartsuiker and Bernolet based their hypotheses of the earliest stages of L2 syntactic acquisition on findings from the L1 syntactic learning literature (e.g., Tomasello [2000] proposes that syntactic representations in children are initiated around specific lexical items). Because no L2 learning data were available to test the earliest stages of the developmental account, it was necessary to test *beginning* L2 learners, as this would provide insights into the learning processes that take place from the earliest stages of L2 syntactic learning up until learners have become sufficiently proficient in their L2.

Consequently, Muylle et al. (2021a) used an artificial language (AL) to test how beginning learners formed AL syntactic representations during the early stages (priming within the AL) up until these representations become shared with existing L1 (Dutch) syntactic representations (they tested cross-language priming in both directions: priming between the AL and Dutch and between Dutch and the AL). During the longitudinal structural priming study, which comprised five different sessions, participants were tested on their knowledge of transitive and ditransitive sentence structures. The artificial language allowed Muylle et al. to test the predictions of the developmental account in a highly controlled way. Specifically, using their AL, the researchers could control participants' exposure to the language, since the participants could only use the language during the priming experiments in the lab. For the transitive structures, Muylle et al. discovered significant abstract structural priming effects during the initial session, both within the AL and from Dutch to the AL. However, the magnitude of structural priming did not increase over time, implying that the learners had quickly established strong AL structural representations that did not change once they had been formed. For the ditransitive structure, abstract structural priming within the artificial language and from the artificial language to Dutch was significant during the first session, while abstract structural priming from Dutch to the artificial language was only found after the second session. Several implications arise from the study of Muylle et al.: (1) abstract structural representations seem to develop very rapidly, within and between-languages. This is different from natural L2 learning, in which low proficient L2 speakers do not show abstract structural priming (e.g., Bernolet et al., 2013). The rapid sharing may be due to the nature of the artificial language, which consisted of a simplified vocabulary and grammatical structures. (2) The emergence of within-and between language priming of the transitive happened earlier than priming for ditransitives, which suggests that sharing goes faster for some structures than for others.

As abstract priming effects were found earlier than hypothesized, the findings of Muylle et al. (2021a) did not provide conclusive evidence for the L2 syntax acquisition account, which predicts that within-language priming occurs before between-language priming. The study of Muylle et al. demonstrates that abstract structural representations may be developed rapidly in an artificial language, but this may not necessarily mirror the complexity of learning natural languages. For this reason, this dissertation addresses similar questions as Muylle et al., but in an ecologically valid context. Moreover, it focuses on examining the effect of L2 proficiency on L2 and L1-L2 structural priming and it explores the potential applications of structural priming for L2 syntactic teaching. In the following section, I lay out the objectives of this dissertation and I provide an overview of the chapters in this thesis.

Objectives and Overview of this Dissertation

The **first objective** of this dissertation was to test the predictions of Hartsuiker and Bernolet's (2017) developmental account of L2 syntactic acquisition in an ecologically valid learning situation, using a diverse group of L2 learners, who are not only exposed to their new language during language classes, but who are also exposed to their L2 outside a class-context. We also investigated whether lexical repetition may enhance the formation of the abstract structural representation for the passive structure, as beginning learners have been found to strongly depend on lexical overlap (see Bernolet et al., 2013).

We tested the first objective in **Chapter 2**. That is, **we investigated how the transition between item-specific and abstract syntactic representations takes place for transitive structures in a within-Dutch structural priming experiment**. In a longitudinal and a cross-sectional design, we tested whether and when a diverse group of late learners of Dutch show priming for active and passive sentences, and whether the learning of the passive structure can be sped up by means of a lexically-based intervention halfway through the priming experiment. We found that active priming took place before passive priming, which we expected since actives occur more frequently than passive sentences. However, abstract representations of the passive structure seemed to be formed quite rapidly after exposure, and this seemed to be accelerated by our lexically based intervention.

The **second objective** of this dissertation was to investigate the scenario where a highly frequent L2 syntactic structure is morphosyntactically dissimilar from its L1 counterpart, and the low frequent L2 syntactic alternant is similar in both languages of a bilingual. From the predictions of the developmental account, it is unclear whether L2 learners initially learn and establish a syntactic representation for similar, but low frequent, L2 syntactic structures, or whether they always first establish a syntactic representation for the more frequent L2 syntactic alternant, even if this structure is morphosyntactically different from its L1 counterpart.

In **Chapter 3**, we employed a structural priming experiment with within (Spanish-Spanish) language and between (Dutch-Spanish) language trials, to **investigate to what extent L2 learners of Spanish would show priming for active and passive structures, and whether a lexically-based intervention would boost the production of both transitive structures in subsequent trials**. In Spanish, the active structure, the most frequent transitive alternant, is morphosyntactically *dissimilar* from the one in Dutch ("*La chica saluda al chico*" – "*Het meisje groet de jongen*" [The girl greets the boy]). In this example, the patient (the boy) is preceded by the direct object marker *al*, which agrees with the patient's gender. In Dutch, such a direct object marker does not exist. The passive structure, the less frequent alternant, is similar between both languages ("*El chico es saludado por la chica" – "De jongen wordt gegroet door het meisje*" [The boy is being greeted by the girl]). We found passive priming regardless of the prime language; and the intervention boosted passive production in subsequent trials without verb overlap. We did not find active priming, but we observed that advanced bilinguals were more likely to produce the morphosyntactically *dissimilar* Spanish active structure (though not always in a correct way) than less advanced bilinguals. Interestingly, we observed that our lexically-based intervention boosted the correct usage of the dissimilar L2 active structure. We suggest that a lexically-based intervention may not only induce the formation of abstract structural representations, but it may also promote the correct usage of dissimilar L2 structures. Finally, we believe that structural priming studies should incorporate aspects of the residual activation theory and the implicit learning account to better understand how bilinguals form syntactic representations in the L2 and between the L1-L2, particularly when it concerns the acquisition of dissimilar L2 structures.

The **third objective** of this dissertation was to investigate whether L2 learners can be primed to produce *dissimilar* (and less frequent) L2 syntactic alternants in their second language if they can choose to produce the alternative construction that is *similar* (and more frequent) between the L1 and L2. This objective was important to investigate as it is unclear if and how the presence of a similar L1-L2 syntactic structure affects the learning process of a dissimilar L1-L2 syntactic alternant (cf. Muylle, 2021b). One assumption that has been put forth is that the presence of a similar L1-L2 structure may block the learning, and eventually, the sharing of the dissimilar L2 structure, but this has only been tested in an artificial language (Muylle, 2021b). In addition to this, I examined to what extent L2 proficiency plays a role in the priming of dissimilar L2 structures.

In **Chapter 4**, **we investigated the priming of Dutch (PP-final and PP-medial) passives in a within-Dutch structural priming experiment in French-Dutch bilinguals**. In contrast to Dutch, French only allows the PP-final passive, and the PP-medial passive does not exist in this language. In our priming experiment, we observed an unexpected production preference for the PP-*medial* structure. There was priming for both PP-final and PP-medial passives, implying that the learners had established a representation for the similar and dissimilar L2 structure. We discovered that the learners had been explicitly taught to use the PP-medial passive structure. This, together with L2 proficiency, affected the production biases and structural priming: lower L2 proficiency speakers mostly produced PP-medial passives and showed strong PP-final priming, whereas higher proficiency L2 speakers produced PP-medial and PP-final passives, creating room for PP-medial priming. It appears that L2 proficiency is an important factor for the priming of both similar and dissimilar L2 syntactic structures.

The **fourth objective** of this dissertation was based on our unexpected finding in Chapter 4 (we discovered that French-Dutch bilinguals prefer PP-medial passives during spontaneous production). We used structural priming to study whether it can be used as an intervention tool to boost the production of the less frequently used PP-final passive structure.

In **Chapter 5**, **we investigated whether an increase in PP-final passive primes would incite French-Dutch bilinguals to spontaneously use this structure more often** during the formulation of target pictures. Usually, the proportion of prime sentences is equally divided across the prime conditions. In Chapter 4, all three prime conditions, namely, the PP-final passive, the PP-medial passive, and the baseline condition equally comprised 33.33% of the prime items. However, in our priming experiment in Chapter 5, we increased the proportion of PP-final passive primes to 50% (vs. 33.33% PP-medial passive primes and 16.67% baseline items) to boost its usage during the description of target pictures. We found that learners produced more PP-final passives in the baseline condition. Moreover, we observed stronger PP-medial priming than PP-final priming. Furthermore, PP-final priming was weaker for advanced bilinguals than for less advanced bilinguals, because the proportion of PP-final passives in the baseline condition increased together with participants' proficiency. We suggest that our manipulation may be useful to L2 teaching practices, especially when L2 learners are confronted with learning dissimilar L2 syntactic structures.

Finally, the **last objective** of this dissertation was to conduct a norming study with the picture stimuli that were specifically created for this project and were used in the experiments in Chapters 2 and 3.

Chapter 6 reports **a norming study amongst Dutch children** aged 6-12 years. The objective was to investigate whether the children would correctly interpret our set of 208 color drawings, which we had developed for longitudinal research on the production and comprehension of transitive sentences, if the transitive action on each drawing was described with an active or a passive sentence. The children provided 93.02% correct answers to our pictures, which indicates that the pictures are clear in terms of how the transitive actions are displayed. Several factors contributed to an incorrect interpretation of a transitive action in a picture. (1) Pictures were more difficult to interpret when a passive sentence was used to describe a transitive event compared to an active sentence; (2) children made more errors interpreting pictures when abstract transitive verbs were used to describe an action (e.g., the verbs “to overtake”, and “to replace”); (3) children had difficulty interpreting our pictures when particular verbs (“roepen” [to shout] and “volgen” [to follow]) were presented in a passive sentence, while other verbs (“blokkeren” [to block] and “inhalen”) rendered more correct answers when the transitive event was described with a passive sentence; finally, (4) younger children provided more incorrect answers to our pictures than older children, regardless of whether the transitive action in the picture was described with an active or a passive sentence. We believe that our picture set is not only useful to test L2 acquisition in late learners (Chapters 2 and 3), but our norming study demonstrated that it is also useful to researchers who intend to investigate the acquisition of transitive structures in children.

In Chapter 7, **I summarize the most important findings from all the chapters in this thesis**. In the general discussion, I explain the findings based on the predictions of the developmental account and on the lexicalist and implicit learning accounts. I lay out the limitations of my experiments, and I suggest important factors that should be considered for future research, one of them being the strong effect of explicit language teaching on L2 structural preferences.

CHAPTER 2

THE DEVELOPMENT OF ABSTRACT SYNTACTIC REPRESENTATIONS IN BEGINNING L2 LEARNERS OF DUTCH

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*These authors contributed equally to this work.

All data, analysis code, and experimental lists are available at:

https://osf.io/x8ejm/?view_only=60a652af276843e8835b8ffd797e29c0

Abstract

The developmental account of second language (L2) syntactic acquisition in late learners (Hartsuiker & Bernolet, 2017) predicts that learners start with item-specific syntactic representations, which become abstract over time. We investigated how the transition between item-specific and abstract syntactic representations takes place for transitive structures in a within-Dutch structural priming experiment. In a longitudinal and a cross-sectional design, we tested whether and when late learners show priming for active and passive sentences, and whether the learning of the passive structure can be sped up by means of a lexically-based structural priming intervention. Active priming took place before passive priming, although abstract representations of the passive may be formed quite rapidly after exposure, which seemed to be accelerated by the intervention. Our results suggest that a developmental account of L2 syntactic acquisition should be a hybrid model, incorporating aspects of the residual activation account as well as an implicit learning mechanism.

Keywords: L2 acquisition, late learners, syntax, structural priming, abstract structural representations

1. Introduction

Moving or migrating to a new country often entails being confronted with learning the language of one's new home. When a language is learned, syntactic representations are formed that are used for the comprehension and the production of syntactic structures. But how does this late learning of syntactic structures occur and when in the learning trajectory do late learners establish structural representations of syntactic structures ready for production?

In this paper, we ask how late adult learners of Dutch, who are at the very beginning stages of language learning, establish abstract syntactic representations for active (*The girl reads the book*) and passive sentences (*The book is being read by the girl*). Testing the predictions of a developmental account of second language (L2) syntactic acquisition (Hartsuiker & Bernolet, 2017), we hypothesize that late learners have the tendency to produce active sentences spontaneously and not passive sentences, as passives are less frequent. This would suggest that learners may not have a syntactic representation for passives yet. Here, we investigated *when* in the learning trajectory transitive syntactic representations are formed, and we tested our research question with *structural priming*.

Structural priming is the tendency to reuse previously processed syntactic structures (Bock, 1986), and it allows researchers to investigate how syntactic information is represented and accessed during syntactic processing (Pickering & Ferreira, 2008; Mahowald et al., 2016). For instance, speakers have a stronger tendency to use a passive structure (*The boy is being bitten by the dog*) after hearing a passive sentence (*The cake is being baked by the cook*) than when they have just heard its active counterpart (*The cook bakes the cake*). As such, structural priming is a way to elicit less frequent alternatives that may not be produced spontaneously, and it is believed that structural priming only occurs if the speaker has a mental representation of the syntactic structure (Pickering & Ferreira, 2008). According to

Pickering and Branigan (1998), the speaker's lexicon contains a distinct combinatorial node of the syntactic structure linked to lemma nodes that can be used with that structure. In our case, if beginning learners show a tendency to produce a passive sentence instead of an active sentence, after hearing a passive prime, this suggests that they have developed a structural representation for the passive.

Syntactic representations in bilingual speakers

Work on structural priming in bilingual speakers suggests that bilinguals share syntactic representations whenever syntactic structures are *similar* enough between the two languages of a bilingual. For instance, in a cross-language structural priming experiment with Spanish-English bilinguals, Hartsuiker et al. (2004) found that participants had a stronger tendency to produce English passive sentences (*The man is bitten* <u>*by the dog*</u>) after they heard a Spanish passive prime sentence (*La cantante es atendida* <u>*por el obrero*</u> "The singer is served by the construction worker"), than when they heard a Spanish active prime sentence. Hartsuiker et al. suggested that between-language priming effects are due to a shared syntactic representation of the passive structure between Spanish and English. Following this assumption, they proposed their bilingual lexical-syntactic model, which is rooted in the residual activation theory (Pickering & Branigan, 1998). Pickering and Branigan suggest that priming of the passive occurs due to short-term residual activation of the lexical representation of a transitive verb (e.g., 'to bite') and the syntactic representation for the passive structure. Importantly, the link between the lexical representation and the syntactic representation is strengthened when both representations are activated. Hartsuiker et al. extended the residual activation theory to bilinguals, proposing that activation of lexical and syntactic representations in one language induces activation of translation equivalents and shared syntactic structures in the other language.

Though the residual activation theory provides an explanation for short-term structural priming effects and for the *lexical boost effect* (there is a larger tendency to repeat a recently processed structure if the same lexical item is used), it does not explain that structural priming effects are long-lived rather than short-lived (Hartsuiker et al., 2008). Structural priming seems to reflect a long-term learning process. Chang et al. (2006) suggested that structural priming effects arise due to error-based learning of syntactic rules, in which learning depends on the difference between syntactic predictions and the actual syntactic structures encountered during processing. This process is influenced by the relative frequency of syntactic alternants, as less frequent structures induce a larger prediction error than more frequent structures. As a result, low frequent structures (e.g., passives), give rise to larger priming effects than high frequent structures (e.g., actives), a phenomenon called the *inverse preference effect* (Ferreira & Bock, 2006). Importantly, recently, Khoe et al. (2021) have implemented and tested a bilingual version of the implicit learning account, showing that error-based learning indeed plays an important role in L2 learning.

In bilingual speakers, not only the relative frequency of a structure but also proficiency seems to play an important role in the magnitude of structural priming. Bernolet, Hartsuiker, and Pickering (2013) showed that more proficient L2 speakers of English, who had Dutch as their L1, were primed more strongly for genitives (S-genitives: *the girl's shirt* and Of-genitives: *the shirt of the girl*) than less proficient speakers. In contrast, the less proficient L2 learners showed the strongest priming for items with lexical overlap. These results suggest that L2 learners start with non-shared, item-specific syntactic representations in their L2, which become abstract and shared between the L1 and the L2 over time. As such, the magnitude of abstract priming effects increases together with L2 proficiency. Less proficient L2 learners rely on item-specific syntactic representations, which explains why within the L2 lexical overlap between prime and target leads to larger priming effects in less proficient than in more proficient L2 learners.

Developmental account for the acquisition of L2 syntax

In their developmental account for the acquisition of L2 syntax, Hartsuiker and Bernolet (2017) propose a possible account of the process during which syntactic structures become shared over time. According to their account, syntactic development takes place in five stages.

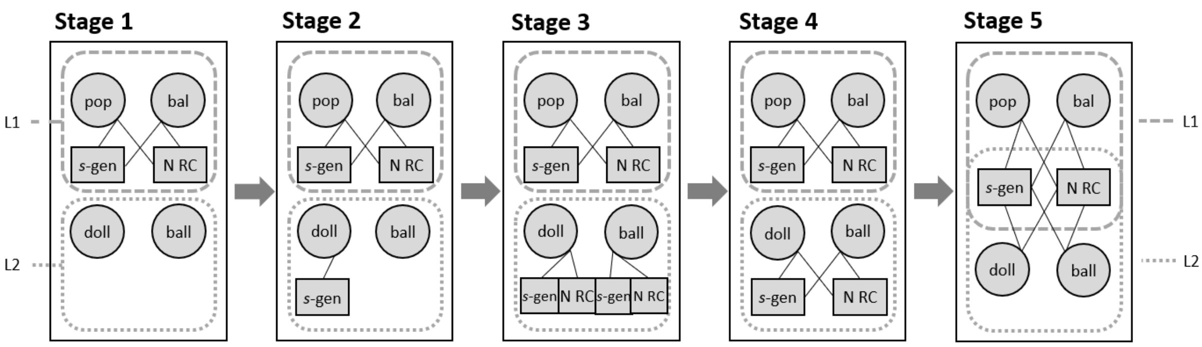


Figure 1 Developmental account for L2 syntax acquisition as proposed by Hartsuiker and Bernolet (2017). The upper part represents the lexical-syntactic network in the L1, and the lower part represents the development of the lexical-syntactic network in the L2.

Stage 1. The learner only has lexical representations without syntactic information connected to them. The learner uses their knowledge of the L1 to formulate sentences in the L2, which may lead to transfer errors. For example, an L2 learner of English with L1 Dutch may produce “the doll from the boy” as a translation of *de pop van de jongen* “the doll of the boy”, as the preposition *van* is the equivalent of both *of* and *from* in English.

Stage 2. The L2 learner will form item-specific syntactic representations of L2 structures. They may learn the phrase “the doll of the boy”, but they might not yet be able to generalize this to other lexical items such as “the ball of the girl”.

Stage 3. More item-specific syntactic representations are added to the lexicon. This means that the L2 learner can use the lexical item in more than one construction. For example, they may be able to alternate between “the doll of the boy” and “the boy’s doll”. However, exposure to these structures is still too low to generalize beyond the item-specific syntactic representations: the learner does not know yet whether the construction is a lexical expression or a more general syntactic pattern.

Stage 4. Based on the recurring patterns [object] of [person] and [person]’s [object], the learner will generalize the construction across lexical items, and is able to use the syntactic construction productively.

Stage 5. Syntactic structures that are sufficiently similar between languages become shared across languages. A shared syntactic structure means that there is one syntactic representation, for instance, [object] [preposition of/van] [person], which is connected to all Dutch and English nouns stored in a bilingual’s lexicon.

The developmental account of Hartsuiker and Bernolet (2017; see also Bernolet & Hartsuiker, 2018) predicts different structural priming effects at the different stages. At the first stage, structural priming will only occur immediately after an item if there is lexical overlap between the prime and target sentence. In this case, learners may copy and edit the prime sentence onto their own target response, using the explicit memory of the prime structure as a cue for retrieval from working memory (see Bernolet et al., 2016). At the second and third stage, lexical overlap will still be necessary to induce structural priming since the representations are item-specific. However, the prime and the target structure do not need to follow each other immediately as explicit memory is no longer the only locus of structural priming and implicit learning has started to play a role (Bernolet & Hartsuiker, 2018). During the fourth stage, one may expect to find abstract structural priming within the L2, but no between-language priming yet. Finally, at the fifth stage, abstract structural priming will occur between languages, provided that the syntactic structures are similar enough to become shared.

Importantly, abstract representations may be formed earlier for more frequent structures (e.g., actives) than for less frequent ones (e.g., passives). Therefore, it might be the case that abstract structural priming effects may be found for frequent structures, whereas lexical overlap is still necessary for the priming of less frequent structures. One could also imagine that verb overlap between several primes and targets may function as a tool to promote the formation of abstract structural priming in primes and targets that do not use verb overlap (for instance, due to implicit learning). As such, the L2 account of syntax implies that lexically based priming aids the formation of abstract syntactic representations.

The formulation of the developmental account (Hartsuiker & Bernolet, 2017) was based on structural priming studies that recruited university students as late L2 learners, who had usually learned the L2 in a classroom context from an early age and were already quite proficient in the L2. For example, the proficiency effects reported by Bernolet et al. (2013) were found in psychology students with L1 Dutch who learned English during high school. Because these late learners were not at the very beginning stages of L2 acquisition, there is a need to test the validity of the developmental account with late learners who start out with little knowledge of their L2.

One way to investigate the early stages of L2 syntactic learning is by teaching participants a new language from scratch. Muylle et al. (2021a) tested the predictions from the developmental account by teaching participants (with Dutch as their L1) an artificial language. They were subsequently tested in a longitudinal structural priming study with five different sessions on their knowledge of transitive and ditransitive sentences. For the transitive structures, Muylle et al. found significant abstract structural priming effects already during the first session. The magnitude of the structural priming effects did not increase over time. By contrast, in some sessions, the priming effects were weaker in the first session. For the ditransitive structure, abstract structural priming within the artificial language and from the artificial language to Dutch was significant during the first session, and abstract structural priming from Dutch to the artificial language was only found after the second session.

As abstract priming effects were found much earlier than expected, the findings of Muylle et al. (2021a) did not provide conclusive evidence for the L2 syntax acquisition account, which predicts that within-language priming occurs before between-language priming, and that lexically based priming is not only found earlier than abstract structural priming, but that it also aids the formation of abstract syntactic representations. Their study shows that abstract structural representations may be developed very rapidly in an artificial language, but this may be different from natural L2 learning.

Though using an artificial language has several advantages (e.g., full control of exposure to the language, see Wonnacott et al., 2008), one of its downsides is that the language is only used within one context (i.e., a lab) and this may influence the learning process and the speed of establishing syntactic representations. Therefore, we set out to test the predictions of the developmental account of L2 syntax acquisition in an ecologically valid learning situation, where exposure to the new language also occurs outside of class, with late learners of Dutch.

Current Study

Based on the predictions of the developmental account of L2 syntactic acquisition (Hartsuiker & Bernolet, 2017), we examined how the transition between item-specific (stage 3) and abstract syntactic representations (stage 4) takes place for transitive structures in beginning learners of Dutch. We investigated the following questions in a within-Dutch structural priming experiment that had a lexically-based intervention block halfway through the experiment:

RQ1: When in the learning trajectory of transitive structures do late learners of Dutch show priming for active and passive sentences?

RQ2: To what extent do several instances of verb overlap in passives (the more complex transitive alternant) boost the production of passive sentences in subsequent trials without verb overlap?

In our experiment, we tested abstract structural priming as well as a possible transfer effect of items with verb overlap on subsequent prime-target trials without verb overlap. We chose to not directly compare priming effects of items with and without lexical overlap (either in a within-participants design or in a between-participants design), since structural priming effects with verb overlap between prime and target pairs are predicted to occur already from stage 1 of the developmental account. Repetition of verbs between prime and target can serve as a cue to the explicit memory of the prime sentence, and participants may use a copy-edit strategy to describe the target picture (Bernolet et al., 2016). Therefore, one may find priming effects even if there is no abstract representation of the more complex structure yet. Hence, such a design would not be very informative regarding the transition from specific representations (stage 3) to abstract representations (stage 4). Consequently, our experiment consisted of three blocks: a pre-intervention block (no verb overlap), an intervention block in the middle of the experiment (with verb overlap between prime and target sentences), and a post-intervention block (no verb overlap). In the pre- and post-intervention blocks, we included active and passive prime sentences as well as a neutral baseline condition to investigate the presence of abstract structural priming of both the less complex and the more complex transitive alternative (see Bernolet et al., 2009, who used a baseline too). The intervention block consisted of only passive prime sentences. In this way, we aimed to boost the production of the more complex and less frequent passive structure during and after the intervention block. Based on our research questions and experimental design, we formulate the following hypotheses:

H1: Abstract syntactic representations for transitives may occur earlier for active sentences than for passive sentences because actives are more frequent. Therefore, we expect to find active priming before passive priming. We expect to find passive priming as the (spontaneous) production of passives increases as a function of proficiency.

H2: Learners may benefit from the few instances of lexical overlap in the intervention in the sense that it may promote the abstraction of less frequent structures in subsequent trials without verb overlap (due to implicit learning processes). This may result in more passive structures post-intervention, compared to pre-intervention, and thus possibly a stronger passive priming effect.

We tested our hypotheses in two different experimental designs, namely, a longitudinal and cross-sectional design. (1) Similar to Muylle et al. (2021a), our longitudinal design consisted of five sessions, in which we investigated the process of establishing syntactic representations *within* learners. (2) For our cross-sectional design, we used a group of lower proficiency and higher proficiency learners of Dutch to investigate whether the different stages of the developmental account would translate to different abstract structural priming patterns based on different L2 proficiency levels *between* learners.

In addition to our two groups of late Dutch learners, it was necessary to also test a Dutch control group to determine whether a few instances of verb overlap affect abstract structural priming of transitive structures in native language users. This was important to investigate since we assume that native speakers have already developed and established syntactic representations for active and passive structures. We anticipated that the lexical boost effect induced in the intervention block, which would presumably lead to stronger passive priming, may extend to the post-intervention block.

For the longitudinal study, we expect active priming from the first few sessions and passive priming in the later sessions. Note that priming effects of the active structure can only be measured if participants (attempt to) produce a passive in at least a small part of the trials. It may be the case that we will only be able to detect active priming from Session 2 or 3, even though we assume that participants already have an abstract representation for the active structure as from Session 1 (if they are able to complete the task of describing pictures).

Since the learners in our longitudinal study were explicitly instructed on the passive structure in their language course, shortly before Session 3, we expect passive priming to occur from Session 3 or 4, depending on how fast abstract representations are formed after learning the structure. Similarly, for the cross-sectional study, we hypothesize that the lower proficiency learners may show active priming, and that the higher proficiency learners may show passive priming.

More generally, we expect that active priming will disappear in the later sessions of the longitudinal study, and that we will not find active priming in the higher proficiency learners of the cross-sectional study, due to the inverse preference effect. Therefore, we expect to find a similar priming pattern to native speakers (see Montero-Melis & Jaeger, 2019) (usually, native speakers do not show active priming but show strong passive priming).

In terms of the effects of the intervention, we predict that participants will use more passives due to a learning effect following from the intervention items with verb overlap. First, the intervention draws attention to the passive structure because of the repeated use of this structure. Second, when participants produce passives during the intervention using a copy-edit strategy, they processed more passives than they would have done in a priming block without lexical overlap, which may lead to faster learning (see Muylle et al. [2021b], who showed that items with lexical overlap also boost structural priming in subsequent items without lexical overlap).

2. Experiment 1: Control group

2.1. Method

2.1.1. Participants

We recruited a group of native Dutch speakers (N = 19) as a control group. There were 13 females, 5 males and 1 other person with an age range from 18 to 29 years old (*M* = 22.6, *SD* = 4.1). For the sake of group comparison, we equally recruited approximately the same number of Dutch native speakers as L2 learners (see below).

2.1.2. Materials

Our materials, designed for the purpose of this study, comprised color drawings [1,064 pictures in total]. All materials are available online in the Supplementary materials [https://osf.io/x8ejm/?view_only=60a652af276843e8835b8ffd797e29c0]**.** To make our materials suitable for the late learners of Dutch in Experiment 2 and 3, we used a limited vocabulary. Based on the learning materials of our late learners, we chose eight professions (animate entities) (e.g., *a baker*, a *singer)* and eight vehicles (inanimate entities) (e.g., *an ambulance*, *a firetruck*). For the pictures that contained animate entities, we chose six different transitive verbs: *to greet*, *to call*, *to help*, *to serve*, *to phone*, and *to carry*. Also, for the pictures with inanimate entities, we chose six different transitive verbs: *to hit*, *to pass*, *to block*, *to replace*, *to drag*, *to follow*. Next to the transitive verbs for the critical trials, we selected intransitive verbs for the filler trials. We had twelve intransitive verbs for the pictures with animate entities (e.g., *to smile*, *to cry*) and twelve intransitive verbs for the pictures with inanimate entities (e.g., *to smell, to stop*). Importantly, our pictures were set up such that, despite the restricted vocabulary, many different noun-verb combinations were possible, while avoiding lexical overlap between items. As the materials were adjusted to the vocabulary knowledge of late learners, the items were easy for the native speakers.

2.1.3. Design

The experiment included audio prime sentences, a verification task, and target description pictures. There were 72 prime sentences, 24 were critical prime sentences, divided over three conditions: the active (*De bakker helpt de zangeres* [The baker helps the singer]), the passive (*De zangeres wordt geholpen door de bakker* [The singer is being helped by the baker]), and the baseline condition, which consisted of conjoined noun phrases (*de bakker en de zangeres [the baker and the singer]*). We included a baseline to determine the production preferences of the learners in an unprimed condition (see Bernolet et al., 2009). Apart from the critical prime sentences, we included an intervention block in the middle of the experiment, consisting of four passive prime sentences. In the intervention block, we repeated the verb between the prime and target. The remaining 44 sentences were fillers, which could be described with intransitive verbs. All prime sentences were recorded into separate audio files.

The verification task, which functioned as a distraction task, was presented simultaneously with the prime trials. Participants listened to the prime sentence while seeing two pictures: the correct picture that matched the prime sentence and a competitor picture. For instance, if participants would hear the prime sentence "*The teacher serves the doctor"*, they would see two pictures. In the correct picture, the teacher is the agent, and the doctor is the patient. In the competitor picture, the doctor is the agent, and the teacher is the patient. The competitor picture could either be described with an active sentence "*The doctor serves the teacher*" or with a passive sentence "*The teacher is being served by the doctor*". We included the verification picture in the prime trials to test whether learners would interpret the first noun phrase that they heard as an agent (active interpretation) or a patient (passive interpretation). The verification for the filler trials consisted of the same object in the correct and competitor picture, but the verb was different in the two pictures. For instance, for the sentence “The teacher *sings*”, the competitor picture would portray a teacher smiling. We manipulated the position of the correct picture and its competitor (i.e., on the left or on the right side of the screen) within each prime item across our experimental lists.

As critical target pictures, we used 24 pictures with transitive verbs that could be used to describe them. For these pictures, we did not repeat the verb of the prime sentence. In this way, we tested abstract structural priming (Pickering & Ferreira, 2008). We counterbalanced the position of the patient within items across our experimental lists, so that passive sentence production could not be related to the position of the patient in the target pictures. We also used 44 filler target items with intransitive verbs. The target verbs were displayed together with the pictures, and participants were told to conjugate the verb to produce a sentence.

Lastly, the prime-target pairs were pseudorandomly mixed with the filler items, with the constraint that the experiment started with three filler items. Each prime-target pair was followed by one, two or three filler items. Based on the experimental conditions, the position of the correct and competitor pictures in the verification task, and the position of the patient in the target items, we created 12 experimental lists to obtain a fully crossed design within items. For the last six lists, we reversed the order of the trials in the experimental lists. That is, all items that preceded the intervention block in the first six lists followed the intervention block in the last six lists. Similarly, all items that followed the intervention block in the first six lists, preceded the intervention block in the last six list. Importantly, we used the same four trials in the intervention block across all experimental lists.

The experiment was programmed in *PsychoPy* v.3.4 (Peirce et al., 2019) and was run on the online platform Pavlovia. The Pavlovia experiment was embedded in a Qualtrics (Qualtrics, Provo, UT) survey, which contained the instructions, the request to provide informed consent and some demographic questions (age, gender, language background)

2.1.4. Procedure

The native speakers received a link to the Qualtrics survey and were asked to provide the researchers with a recording of their spoken utterances after their participation. After the participants had read the instructions and given their consent, they were instructed to turn on an audio recording and to start the experiment in Pavlovia. At each trial, participants saw a white screen with an audio button. After pressing the audio button, the prime sentence would start to play, and participants saw the correct picture and its competitor picture. Participants had to click on the picture that, according to them, displayed what they had just heard. Once participants had provided an answer, they saw a white screen with a “speak” button. After pressing the speak button, participants saw a picture for the target item accompanied with the main verb at the bottom of the target picture, and they had to formulate a sentence. The native speakers took about 20 to 25 minutes to complete the experiment.

2.1.5. Coding

The responses were manually coded as active, passive, or “Other” responses. A response was coded as active if the agent of the transitive event was mentioned first, followed by a conjugated verb and the patient. Passive sentences were coded when the patient was mentioned first, followed by an auxiliary verb (*to be*), a form of the past participle and if the sentence ended with a prepositional by-phrase using the preposition *door* (*by*). For instance, a correct passive response for Figure 2 would be: *De ambulance wordt gevolgd door de tram* - [The ambulance is being followed by the tram]. All other responses, including ‘short passives’, in which the agent was not overtly realized (e.g., *de bakker wordt gegroet* [the baker is being greeted]), were coded as “Other” responses.

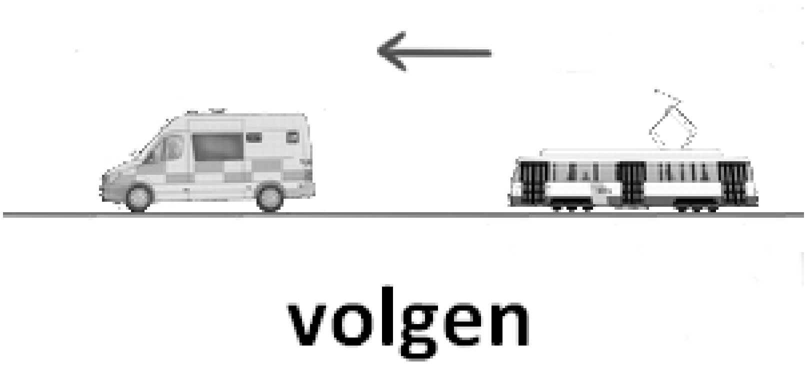


Figure 2 An example of a target picture.

2.1.6 Analysis

We measured the priming effects by comparing the proportions of active and passive responses after an active or passive prime sentence to the proportion of active and passive responses after a baseline prime. The target responses were fit to a generalized linear mixed model (R-package lme4, Bates et al., 2015) with a Bobyqa optimizer to increase convergence (Powell, 2009) in *R* (version 4.1.3). We ran a model with *Prime Condition* (baseline/active/passive) and *Intervention* (pre/post) and its interactions as fixed factors. The baseline *Prime Condition* and *Pre-intervention* served as the reference level. Following the maximal random effects structure as proposed by Barr et al. (2013), we added random slopes and random intercepts for *Participants* and *Items*. The maximal model was simplified in a stepwise way due to convergence and singularity issues. We first simplified the random effects structure by testing if the random slope terms could be omitted without decreasing the fit of the model. We removed random slopes for *Item* before removing any random slopes for

Participant because the variance in items is usually smaller than the variance in participants (Segaert et al. 2016). For the final model, we calculated the conditional and marginal R^2 values, which are measures of the effect size, with the *rsquared* function from the piecewiseSEM package (version 2.1.0., Lefcheck, 2016).

2.2 Results

The native speakers produced 505 responses, of which 395 active responses (74.2%), 110 passive responses (20.7%) and 27 "Other" responses (5.1%). Figure 3 shows the responses per *Prime Condition.* Figure 4 displays the responses of the native speakers during the intervention block.

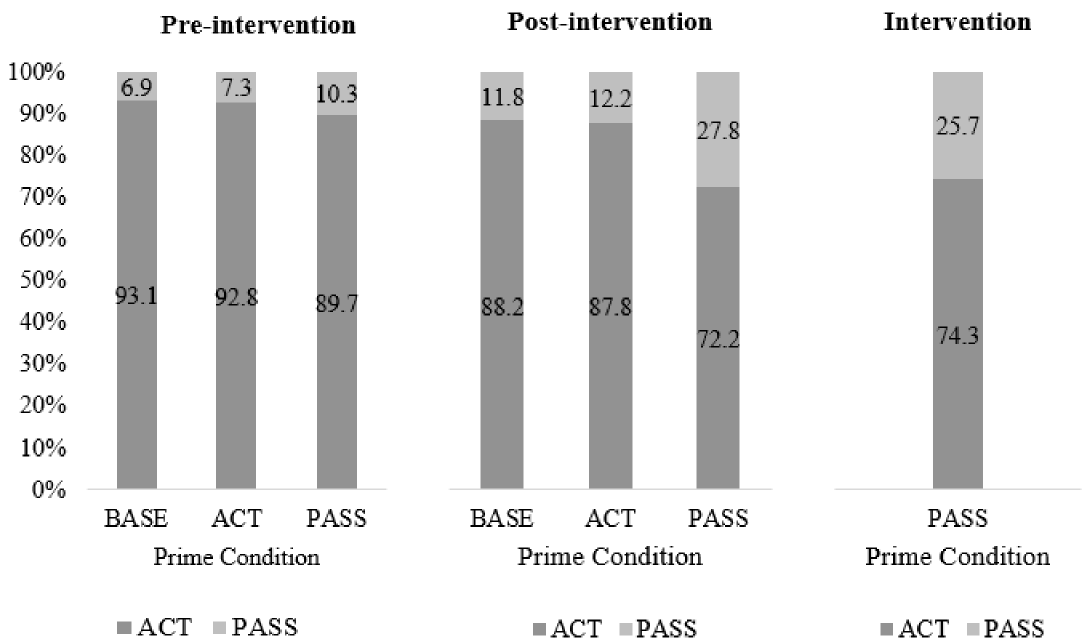


Figure 3 Proportion of passive responses before, after and in the intervention block for the control group.

The final model included random intercepts for *Participant* and *Item* and no random slopes. In the control group, we found significant passive priming ($p < .05$) and significantly more passives after the intervention block ($p < .01$) (see Table 1) than before the intervention block. There was no significant interaction between *Prime Condition* and *Intervention*[1]. The fixed effects of the final model explained 3.94% of the variance (marginal R^2; Nakagawa & Schielzeth, 2013) and conditional on the random effects, they explained 13.40% of the variance.

Table 1. Summary of fixed effects of generalized linear mixed model (N = 431, log-likelihood = -149.5).

	Coefficient	*SE*	Wald's *Z*	*p*-value
(Intercept)	-3.19	0.46	-6.95	<.001***
Condition(ACT)	0.05	0.41	0.11	0.91
Condition(PASS)	0.93	0.37	2.50	<.05
Intervention(Post)	0.95	0.32	2.94	<.01

2.3 Discussion

As expected, we found only passive priming for the control group. This result is in line with the inverse-preference effect (Chang et al., 2006), where the less frequent syntactic alternant shows stronger priming than the most frequent syntactic alternant due to surprisal. Interestingly, the native speakers were strongly influenced by the intervention block: they produced significantly more passives after the intervention compared to before the intervention block. Moreover, whereas they produced 25.7% passives *during* the intervention block, this increased to 27.8% after the intervention. To our knowledge, this effect of our methodological manipulation has not been found for native speakers yet: even though native speakers have already established a firm syntactic representation for passives, a few instances

[1] Descriptively, there seems to be an interaction between *Prime Condition* and *Intervention*. However, this was not confirmed in our model, probably due low statistical power.

of verb overlap in the same syntactic structure boost passive sentence production such that more passive responses (in all conditions) are observed in subsequent trials without verb overlap. This shows the importance of our priming manipulation and, presumably, this manipulation will have a stronger effect in late learners as they might not have yet established an equally strong syntactic representation for the passive structure.

3. Experiment 2: Longitudinal Study

3.1. Method

3.1.1. Participants

For the longitudinal study, we recruited participants who were enrolled in a one-year Dutch language course at a language institute in Antwerp, Belgium. Seventeen participants (10 female, 7 males, between 18-45 years [*M* = 24.1, *SD* = 6.3])) volunteered to participate five times throughout the academic year. The participants had varying first languages (3 Arabic, 3 Russian, 2 Persian, 2 Spanish, 2 Turkish, 1 French, 1 Tajiks, 1 Thai, 1 Afrikaans/English and 1 Ukrainian/Russian). All participants spoke English as their L2 (sometimes in addition to other languages) and learned Dutch as their L3, L4 or L5. At the end of the fifth session, participants received monetary compensation for their participation.

3.1.2. Materials

The materials of Experiment 2 were identical to those of the control group experiment. We used the same materials in each session.

3.1.3. Design

The design of Experiment 2 was similar to that of the control group experiment (Experiment 1) for the Sessions 2, 3, and 4. However, at Session 1 and Session 5, we added comprehension trials to the experiment to collect more data on whether participants interpreted the prime sentences correctly[2]. We created another 72 items, of which 24 were critical items. Both the comprehension prime trials and the comprehension target trials had the same design as the production prime trials. That is, participants would hear the prime sentence while performing a verification task. Half of the comprehension target trials were actives, and the other half were passives. Each of the active and passive target trials were preceded by a baseline, an active or a passive prime sentence. We divided both the production and the comprehension trials into blocks of 12 items each, leading to six production blocks and six comprehension blocks, which alternated each other. There was still an intervention block of four items (two were comprehension trials and two were production trials) halfway through the experiment. By reversing the order of the trials in the experimental list, we did not only establish that all items preceding the intervention in the first six lists followed the intervention in the last six lists, but it also ensured that half of the lists started with a production block and half of the lists started with a comprehension block.

Even though all participants participated in the same language course, individual proficiency still varied, for instance, due to differences in exposure to Dutch outside the language course. Therefore, at Session 4, we had participants take the LexTALE language test (Lemhöfer & Broersma, 2012), to objectively measure participants’ general Dutch proficiency. Importantly, the LexTALE test has been validated and tested to be a reliable predictor of L2 proficiency. Lemhöfer and Broersma showed that the LexTALE scores strongly correlate with self-rating scores on writing, reading, listening, and speaking proficiency. Moreover, we used the LexTALE for practical reasons too: it only takes

[2] Originally, we had planned to add the comprehension trials in all sessions. However, during Session 1 it turned out that the experiment was too long and intensive for the participants. Therefore, we decided to leave out the comprehension trials in Session 2, 3 and 4. To still be able to measure the increase of correct interpretations of the transitive prime sentences, we decided to reinsert the comprehension trials at Session 5. By then, participants had become more proficient in Dutch and the average completion time was much lower than in Session 1.

approximately 5 minutes to complete, and since we were testing beginning learners, we did not want to subject them to a long language experience questionnaire (e.g., LEAPQ test - Marian et al, 2007). We expected that an estimation of their Dutch vocabulary size would be informative enough regarding their familiarity with Dutch words.

3.1.4. Procedure

Participants were tested five times over the course of eight months. There were about six weeks between each session. Participants completed the same experiment during each session, but they always received a different list per session.

The procedure was similar to that of the control group, except that we provided them with assistance. Due to the COVID-19 pandemic, participants were assisted remotely through the phone. We employed research assistants who recorded and noted down all target sentences produced by participants. Prior to Session 1, we sent participants a booklet with illustrations and translations of all the vocabulary used in the experiment to allow them to familiarize themselves with the vocabulary. We also provided participants with a short demonstration video that demonstrated how the experiment would look. For each session, the research assistant called the participant, and first verified whether they understood the setup of the experiment and the assistant repeated the instructions if necessary. Crucially, our research assistants had to adapt to each participant differently depending on how well each participant comprehended Dutch. Naturally, during the earlier sessions, more help was needed than during the later sessions.

The experiment lasted approximately 50 minutes in Session 1. The duration decreased over the course of time. At Session 5, the average completion time was 20 minutes. At Session 1, participants were asked to complete a short questionnaire with questions on their demography and language background. At Session 4, the experiment was followed by the

LexTALE language test (Lemhöfer & Broersma, 2012), which took approximately 5 minutes.

3.1.5. Coding

The coding of responses was identical to that of the control group, except for the treatment of grammatically incorrect responses. Because conjugating the past participle in Dutch is regarded to be difficult for L2 learners due to irregular verbs, we allowed all attempts of the past participle (e.g., **De auto wordt achter**ge**volgd door de motor* [correct: De auto wordt achtervolgd door de motor – The car is being chased by the motorcycle]). If participants used the infinitive form of the verb rather than an (attempted) conjugated form or produced ungrammatical sentences, we coded these responses as “Other”. If participants did not produce a target sentence at all, we coded these responses as “null” responses. “Other” and “null” responses were disregarded in our analyses.

3.1.6. Analysis

Priming effects were measured in a similar way as for the control group (i.e., comparing proportions of active and passive responses after a prime condition vs. the baseline [unprimed] condition) in a GLMER model. Our model consisted of the factors *Prime Condition* (baseline/active/passive), *Session* (1 to 5) and *Intervention* (pre/post) and its interactions as fixed factors. The baseline *Prime Condition* and *Pre-intervention* served as the reference level. *Session* was treated as an ordinal variable. We started with a maximal random effects structure and simplified it until convergence.

3.2. Results

We collected 2232 responses, of which 1105 were actives (49.5%), 666 passives (29.9%) and 461 “Other” responses (20.7%). Table 2 shows the responses per session.

Table 2. Active, Passive and Other responses per session.

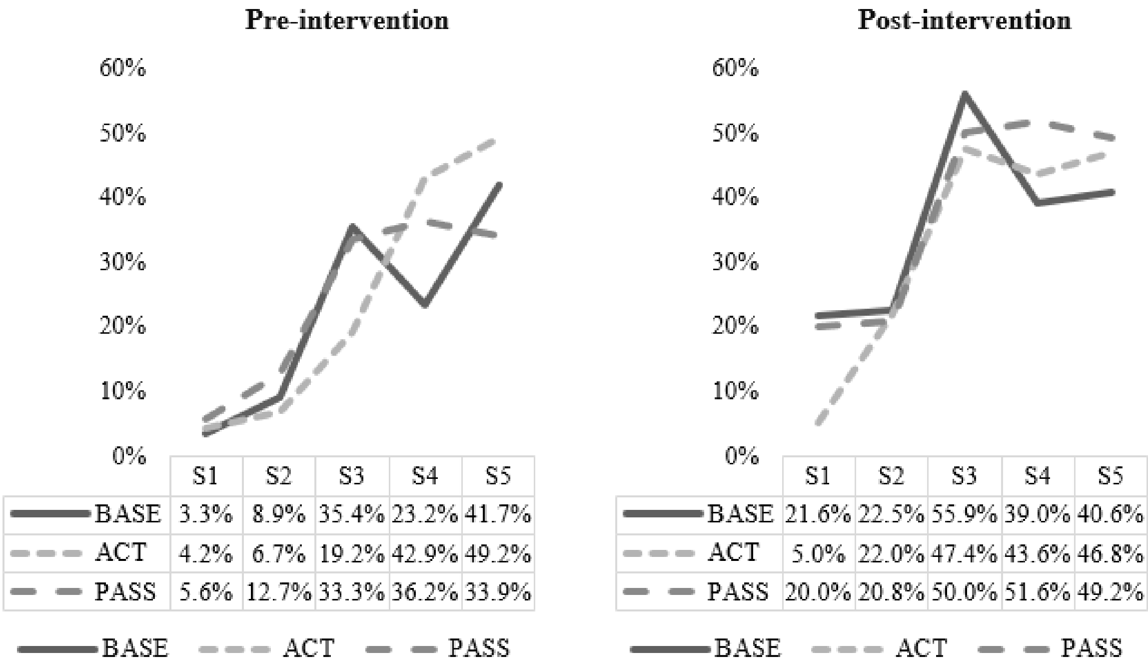
Session	Active	Passive	Other	Total
1	192 (46.2%)	31 (7.5%)	193 (46.4%)	416 (*n = 16)*
2	272 (57.1%)	78 (16.4%)	126 (26.5%)	476 (*n* = 17)
3	195 (43.5%)	174 (38.8%)	79 (17.6%)	448 (*n = 16)*
4	232 (48.7%)	195 (41.0%)	49 (10.3%)	476 (*n* = 17)
5	214 (51.4%)	188 (45.2%)	14 (3.4%)	416 (*n = 16)*

The total number of participants differ per session due to technical issues or illness of participants.

We excluded the "Other" responses from further analyses[3]. Note that the number of "Other" responses strongly decreases, while the proportion of passive responses increases over time. At the same time, the proportion of active responses remains somewhat around the same percentage throughout the five different sessions. This suggests that the increase in passive mainly comes from the decrease in "Other" responses. However, we excluded the "Other" responses in our statistical analysis (see below). This means that we have more observations in the later sessions than in the earlier sessions, mainly due to the increase in passive responses. In our analysis, we only focus on the proportion of active and passive responses rather than absolute numbers. Thus, an increase in passive responses naturally goes at the expense of the proportion of active responses. Figure 5 shows the proportion of passive

[3] The proportion of "Other" responses strongly decreased over time. In the earlier sessions, participants often skipped targets, saying that they did not know how to produce a sentence. In addition, they sometimes produced alternative, non-transitive structures to describe the sentence, such as prepositional phrases. In the later sessions, participants were familiar with the experiment and the sentence structures used in it (participants may have interpreted the prime sentences as examples of desired target responses) and produced fewer alternative structures.

responses per prime condition, per session, per prime condition before and after the intervention. Figure 6 shows the proportion of passive responses per session during the intervention.



	S1	S2	S3	S4	S5
BASE	3.3%	8.9%	35.4%	23.2%	41.7%
ACT	4.2%	6.7%	19.2%	42.9%	49.2%
PASS	5.6%	12.7%	33.3%	36.2%	33.9%

	S1	S2	S3	S4	S5
BASE	21.6%	22.5%	55.9%	39.0%	40.6%
ACT	5.0%	22.0%	47.4%	43.6%	46.8%
PASS	20.0%	20.8%	50.0%	51.6%	49.2%

Figure 4 The proportion of passive responses per session, per prime condition before and after the intervention

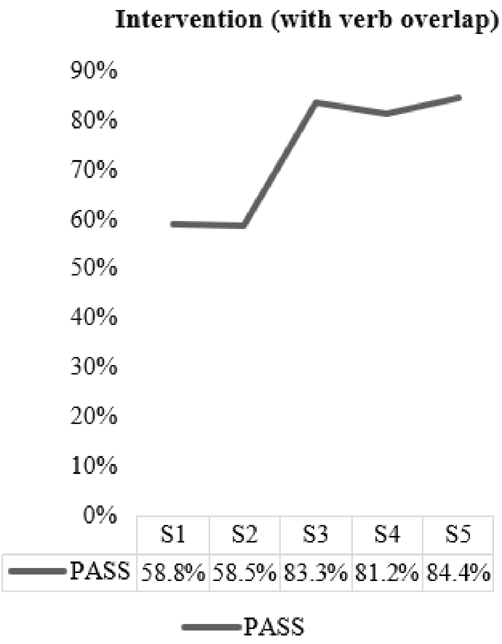


Figure 5 The proportion of passive responses per session in the intervention.

We fit the target responses to a generalized linear mixed model. The final model included random intercepts for *Participant* and *Item*, but no random slopes. The fixed effects of the final model explained 18.68% of the variance (marginal R^2; Nakagawa & Schielzeth, 2013) and conditional on the random effects, they explained 46.65% of the variance. In Table 3, we report the model output.

Table 3. Summary of fixed effects of generalized linear mixed model (N =1551, log-likelihood = -710.4).

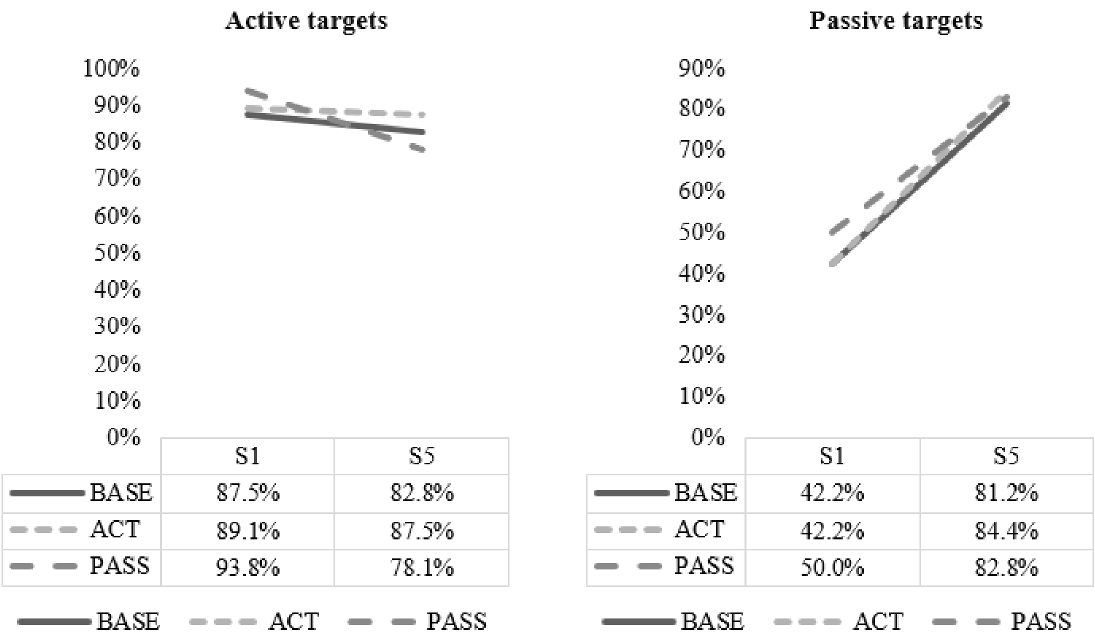
	Coefficient	*SE*	*Wald's Z*	*p*-value
(Intercept)	-2.04	0.41	-5.01	<.001***
Condition(ACT)	-0.26	0.21	-1.22	0.22
Condition(PASS)	0.11	0.18	0.60	0.55

Sessions(L)	2.52	0.47	5.35	<.001***
Sessions(Q)	-0.60	0.42	-1.42	0.15
Sessions(C)	0.17	0.38	0.44	0.66
Sessions(4)	0.85	0.33	2.61	<.01**
Intervention(Post)	1.10	0.18	6.13	<.001***
Condition(ACT)*Sessions(L)	1.55	0.56	2.78	0.01
Condition(PASS)*Sessions(L)	0.27	0.45	0.59	0.55
Condition(ACT)*Sessions(Q)	-0.50	0.50	-0.99	0.32
Condition(PASS)*Sessions(Q)	-0.01	0.42	-0.02	0.98
Condition(ACT)*Sessions(C)	0.08	0.45	0.17	0.86
Condition(PASS)*Sessions(C)	-0.52	0.41	-1.27	0.20
Condition(ACT)*Sessions(4)	-1.01	0.38	-2.65	<.01**
Condition(PASS)*Sessions(4)	-0.65	0.37	-1.76	<.1.
Sessions(L)*Intervention(Post)	-1.12	0.46	-2.42	<.05*
Sessions(Q)*Intervention(Post)	-0.21	0.42	-0.50	0.62
Sessions(C)*Intervention(Post)	-0.03	0.37	-0.10	0.92
Sessions(4)*Intervention(Post)	0.15	0.32	0.48	0.63

Note: the variable Sessions is an ordinal variable. The model uses polynomial contrasts. L refers to a linear predictor, C to a cubic, Q to a quadratic and 4 to the fourth derivative.

The results indicate that the proportion of passives increase linearly over time ($p < .001$), then stabilizes ($p < .01$). Participants also produce more passives after the intervention than before the intervention ($p < .001$), but this effect decreases linearly over time ($p < .05$). There is a significant interaction between the active prime condition and the fourth derivative of *Session* ($p < .01$), indicating that participants produce more active sentences after an active prime sentence (i.e., active priming) in the earliest session. The active priming effect diminishes in the next two sessions. In Session 4, participants produce more passive sentences after an active prime than after a baseline prime. This effect disappears again in Session 5.

At Session 1 and Session 5, we also included blocks with comprehension target items. At Session 1, participants indicated the correct picture corresponding to the target item in 67.4% of the cases. Accuracy was much higher for active (90.1%) than for passive sentences (44.8%). In the intervention, they were correct in 37.5% of the sentences (note that there were only passive sentences in the intervention, which were more difficult to understand for our participants). At Session 5, the accuracy increased to 82.5%, and the accuracy was identical for active and passive sentences. In the intervention, participants responded correctly in 87.5% of the sentences. Figure 7 shows the proportion of correct responses per Prime condition for both sessions.



Active targets	S1	S5
BASE	87.5%	82.8%
ACT	89.1%	87.5%
PASS	93.8%	78.1%

Passive targets	S1	S5
BASE	42.2%	81.2%
ACT	42.2%	84.4%
PASS	50.0%	82.8%

Figure 6 Correct responses in the comprehension targets, per prime condition per Session.

At Session 4, participants performed the LexTALE test to measure their proficiency. Scores varied between 48.75% and 78.75%. The mean score was 58.0% (SD: 7.0%). Exploratory analyses showed that the LexTALE scores did not affect the outcome variable in the priming experiment.

3.3 Discussion

The results of the longitudinal study show an increase of the use of the passive structure over sessions. The growth decreases after Session 4. We find structural priming effects of the active structure at Session 1 after the intervention and significantly more passives after an active prime than after a baseline prime at Session 4 before the intervention. Especially for the earlier sessions, participants produce more passives after the intervention than before the intervention. This pattern is in accordance with our expectations, as the intervention block seems to promote the learning of passives, which is especially relevant for learners at earlier stages of language development who still rely on item-specific representations rather than abstract structural representations.

Nevertheless, in contrast to our expectations, we did not find priming of the passive structure in the later sessions of the longitudinal study, although at this stage, the learners are certainly proficient enough to produce the passive structure, given the overall high proportion of passive responses and the high accuracy rates in comprehension at Session 5. This may be due to long-term learning effects of the earlier sessions. Because the passive structure is more complex than the active sentences and the intransitive filler sentences, participants may have become aware of the fact that we were interested in the passive structure. Interestingly, in the debriefing survey after the final session, participants reported to have noticed our interest in the passive structure during the experiment. This may have led to a relatively high overall proportion of passive sentences in the later sessions. Importantly, the surprisal effect that plays a role in inducing priming effects may thus have been weaker due to the repeated sessions, although it is also possible that other mechanisms may have been at play. Therefore,it is important to cross-validate our findings in a cross-sectional study.

The awareness of the passive structure may also explain the significantly higher proportion of passive sentences after an active prime than after a baseline prime at Session 4 before the intervention. A transitive prime sentence, be it an active or a passive prime sentence, may have made participants more aware of the choice between the active and the passive sentence while producing the target sentence. The motivation of the participants to demonstrate their abilities and to learn from the experiment themselves may have triggered them to try to produce the more complex passive structure. As such, the longitudinal design turned out to be useful to test the very early stages of language learning, that is, to prime a structural alternation before one of the alternatives was learned, but the repeated measures design did not allow us to follow the developmental path of language learning.

4. Experiment 3: Cross-Sectional Study

4.1 Method

4.1.1. Participants

We recruited participants who were taking Dutch classes at a center for adult education based in Antwerp. For the lower proficiency group, we recruited students who were learning Dutch in level 2 (A1/A2 level). For the higher proficiency group, we recruited students from level 3 and 4 (B1/B2 level).

Eighteen participants from the low proficient group and 20 participants from the high proficient group participated in our study. There were 23 females and 15 males, who were between 19 and 53 years (M=33.7, SD= 7.6). The participants had varying first languages (Tigrinya, Turkish, Twi, Urdu…), but Arabic occurred the most (there were 7 native speakers of Arabic). Most participants indicated English as their L2 (amongst other languages), which means Dutch was either their L3, L4, L5 or L6. All participants gave their consent before participating in our experiment and received a monetary reward for their participation.

4.1.2. Materials

The materials of Experiment 3 were identical to those of Experiment 2.

4.1.3. Design

The design was similar to the design of Experiment 2. We did not include the comprehension blocks from the longitudinal study. Different from Experiment 1 and 2, however, is that this experiment was run in Qualtrics (Qualtrics, Provo, UT). We employed Qualtrics for this experiment because a pilot test (N = 4) showed that using *PsychoPy* was too effortful for the participants, and as a result, we were not able to collect a single complete datafile during the pilot study. In addition, Qualtrics is not only computer friendly but also mobile phone friendly, as some participants in this study only had a mobile phone at their disposal.

4.1.4. Procedure

The procedure of Experiment 3 was largely similar to that of Experiment 2. Participants were also tested remotely through the phone with the help of research assistants. For Experiment 3, we filmed two short demonstration videos: one for personal computer users and one for mobile phone users.

Participants had to manually press the play button to listen to the prime sentence in Qualtrics, and thus, the research assistants emphasized that they could only play the audio prime sentences once. At the end of the experiment, participants were asked to fill out the same background questionnaire as in Experiment 2. The experiment lasted approximately 50 minutes for the learners in level 2 and 25 minutes for the learners in level 3 and 4.

4.1.5. Coding

We coded the responses of Experiment 3 according to the same coding scheme as that of Experiment 2.

4.1.6. Analysis

Our full model consisted of a three-way interaction between *Condition* (baseline, active, passive) * *Proficiency* (lower proficiency learners vs. higher proficiency learners) * *Intervention* (pre vs. post). The baseline condition, the lower proficiency speakers and the pre-intervention were the reference levels. The dependent variable *Target response* (active vs. passive, with active as reference level) was binary. Similar to the analysis of Experiment 1 and 2, we used a Bobyqa optimizer to increase convergence. The maximal random effects structure consisted of *Condition* and *Intervention* as random slopes within *Participant*, and

Condition, Proficiency, and *Intervention* as random slopes within *Item*. Moreover, we simplified our maximal model until it converged, and no singularity issues were detected (similar to Experiment 1 and 2).

4.2 Results

The 38 participants produced a total of 1,064 responses, of which 616 (57.9%) were active sentences, 169 (15.9%) passive sentences and 279 (26.2%) 'Other' responses. There was one participant in the low proficient group who only produced 'Other' responses, and thus, we excluded this participant from our analyses. Figure 6 shows the proportion of active and passive responses of the lower and higher proficiency speakers before and after the intervention. Before the intervention, the lower proficiency speakers only produced passives when they were primed with a passive structure, whereas the higher proficiency speakers produced passives in all conditions. Interestingly, before the intervention, the higher proficiency speakers produced slightly more passives in the active prime condition than in the passive prime condition. After the intervention, both groups of speakers produced passives in all conditions, with the highest proportion of passives in the passive prime condition.

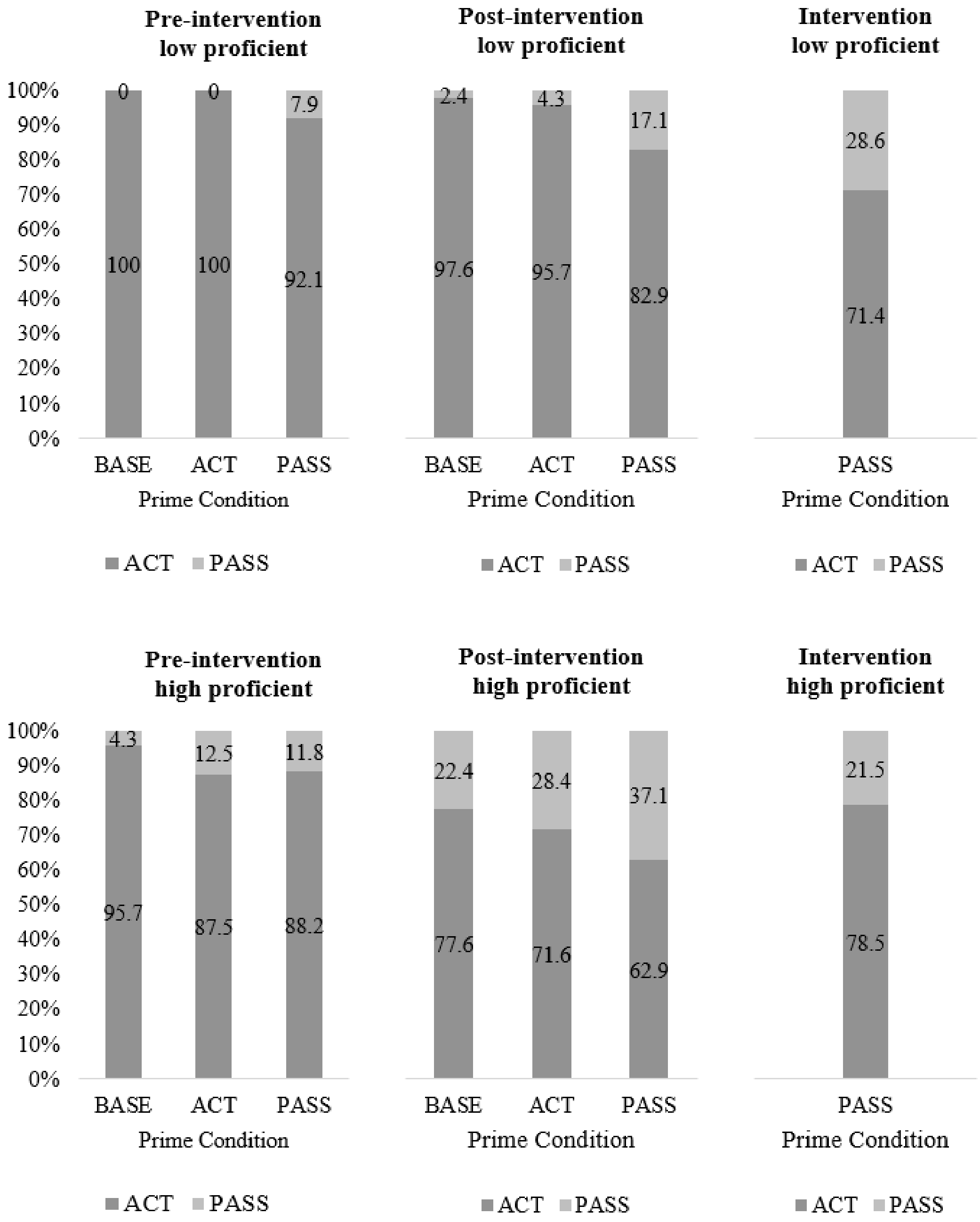


Figure 7 Proportion of active and passive responses before and after the intervention block for the lower and higher proficiency speakers.

Our final model consisted of significant main effects for *Condition* ($p < .001$), *Proficiency* ($p < .001$) and *Intervention* ($p < .001$). The fixed effects of the final model explained 14.84% of the variance (marginal R^2; Nakagawa & Schielzeth, 2013) and conditional on the random effects, they explained 28.20% of the variance.

We found significant passive priming for the lower and higher proficiency learners ($p < .001$). We also observed a main effect of *Proficiency*: higher proficiency speakers significantly produced more passives in the baseline condition compared to lower proficiency speakers ($p < .001$). Lastly, the number of passives increased significantly in the baseline condition in the post-intervention block compared to the baseline condition in the pre-intervention block ($p < .001$) for both proficiency levels. Interestingly, we observed a marginal negative structural priming effect for actives (see third row, Table 4). This marginal effect suggests that the learners produced more *passives after an active prime condition than after the baseline condition.* This tendency can also be seen in Figure 8 where, for instance, descriptively, the higher proficiency speakers produced more passives when they were primed with an active prime than when they encountered a baseline condition. We did not find interactions between our predictors, probably because of the small number of observations in the data.

Table 4. Summary of fixed effects of generalized linear mixed model (N =664, log-likelihood = -218.9).

Fixed effects	Coefficient	SE	Wald's Z	*p*-value
Intercept	-5.04	0.65	-8.30	<.001***
Condition(ACT)	0.63	0.34	1.83	<.1 .
Condition(PASS)	1.21	0.33	3.65	<.001***
Proficiency(HighProficient)	2.04	0.59	3.43	<.001***
Intervention(Post)	1.50	0.28	5.50	<.001***

4.3 Discussion

The results for the cross-sectional study show that proficiency, the intervention with lexical overlap and abstract priming of the passive all contribute to the production of passives. Participants who are more proficient, produced more passives than participants who are less proficient. The intervention positively affected the production of passives in both groups, which is noticeable in the increase of passives in the post-intervention block. This highlights the importance of our intervention manipulation. Though we expected to find different priming patterns for the lower and higher proficiency learners, the results show no difference between the two groups, as both types of learners showed significant passive priming. Importantly, the lower proficiency speakers were probably not at the very beginning stages of learning Dutch (like the learners in the first session of the longitudinal study), since they might have already been exposed to the passive sentence structure and may have formed a syntactic representation for this structure. Moreover, both the lower and higher proficiency learners produced more passives after the intervention block than before the intervention, which goes against our expectations. We predicted that the lower proficiency learners would show a larger increase in the number of passives post intervention than pre-intervention compared to the higher proficiency speakers. In fact, note that numerically, the higher proficiency learners display a larger increase in passive responses than the lower proficiency learners within the intervention (see General Discussion below).

5. General Discussion

Revisiting the research questions

RQ1*: When in the learning trajectory of transitive structures do late learners of Dutch show priming for active and passive sentences?*

We found active priming only in the very beginning stage of learning (i.e., only at Session 1 of the longitudinal study), implying that active priming becomes weaker with increasing proficiency. Note that it is not surprising that active priming disappears over time, since L2 production patterns might become more native-like with increasing proficiency (Hartsuiker & Bernolet, 2017; Montero-Melis & Jaeger, 2019). In native speakers, due to the inverse preference effect, active priming is usually not found while strong passive priming is observed. Nevertheless, in Experiment 2, the disappearance of active priming over time is probably not the result of the inverse preference effect since active priming disappeared, but, unexpectedly, we did not observe passive priming (note, however, that the proportion of passives increased in later sessions compared to earlier ones, see Discussion of Experiment 2). Active priming may therefore have decreased for other reasons.

More specifically, in Session 4 of the longitudinal study and in the cross-sectional study, we found a negative structural priming effect in the active prime condition. That is, participants produced more passive sentences after an active prime than after a baseline prime. A transitive prime sentence, be it an active or a passive prime sentence, may have made the high proficient learners more aware of the choice between both transitive structures while producing a target sentence. They might also have practiced the alternation between active and passive sentences explicitly during their language course. Consequently, an active prime may have reminded them of the passive structure. As most participants indicated that they believed that we were testing their knowledge of the passive, they might have chosen to produce the more complex alternative even after an active prime. As a result, the structural priming effect of the active structure might have become weaker over subsequent sessions, and even negative in Session 4.

The number of passives produced across prime conditions is larger for higher proficiency learners than for lower proficiency learners, both in the longitudinal study and the cross-sectional study, suggesting that the abstract structural representation for passives becomes stronger upon increasing proficiency. This is also reflected in the passive priming effects. In the longitudinal study, we do not find passive priming, although some passives are produced across prime conditions already in Session 1. We assume that abstract syntactic representations for the passive structure are not present in the very early stage of language learning, and the production of passives may be the result from L1 transfer or a copy-edit strategy. In the cross-sectional study, we find significant passive priming in both the lower proficiency and the higher proficiency speakers. The lower proficiency speakers in the cross-sectional study, who were probably not at the very beginning stages of language learning, may have already been exposed to the passive structure (e.g., during reading), and therefore, might have formed a syntactic representation for this structure, at least in comprehension.

RQ2*: To what extent do several instances of verb overlap in passives (the more complex transitive alternant) boost the production of passive sentences in subsequent trials without verb overlap?*

Participants produce more passives after the intervention than before the intervention, which is the case in our L1 control group as well as in the L2 learners in the longitudinal and the cross-sectional study. This suggests that the intervention boosts the production of passive sentences in subsequent trials without verb overlap, at least partly due to increased attention towards the passive structure. In addition, participants in the longitudinal study showed a stronger increase of passives after the intervention in the earlier sessions than in the later sessions, which implies that very low proficient learners benefit more from the intervention in subsequent trials without verb repetition than more proficient learners. This proficiency effect suggests that the intervention may accelerate the development of abstract structural representations in participants who have not yet developed an abstract structural representation of the passive.

We also looked at the effects of the intervention regard to what happens *within* the intervention block. In the intervention items itself, descriptively, more passives were produced by the higher proficiency learners in the cross-sectional study than by the lower proficiency learners. This was unexpected since the developmental account of Hartsuiker and Bernolet (2017) predicts that lower proficiency learners rely more on verb overlap between primes and targets than higher proficiency speakers. Similarly, participants produced more passives in the intervention in the later sessions of the longitudinal study than in the earlier sessions. Thus, although we observed a strong lexical boost effect in the lower proficiency speakers, it seems that the passive was boosted stronger in the higher proficiency learners than in the lower proficiency speakers during the intervention block. There are possibly two main components leading to the lexical boost effect, namely explicit memory, and residual activation of the structural representation of the passive. Whereas explicit memory plays a role in both the lower and higher proficiency learners (explaining the increase in the use of passives during the intervention in both groups), residual activation may only be present in learners with stronger structural representations of the passive, and this may be why higher proficiency learners display a larger lexical boost effect than lower proficiency learners. Indeed, we also find a large lexical boost effect in the intervention in our control group of native speakers. Moreover, the higher proficiency speakers probably used more passives than the lower proficiency speakers because the passive is a complex structure which required conjugating the past participle. It could have simply been the case that the lower proficiency speakers did not produce as many passives as the higher proficiency speakers during the intervention due to the complexity of the passive structure.

6. Limitations and Future Directions

A limitation of the current study is that our sample size did not meet the recommendations of Mahowald et al. (2016) to reach sufficient statistical power. We were not able to find enough participants, since we tested a very specific group of learners; and we could not increase the number of test items as the task was cognitively demanding for the participants. For this reason, our results should be interpreted with some caution. Nevertheless, we still have an estimated power to detect abstract structural priming of more than 60% for the longitudinal group (16 critical items (excluding baseline items * 5 sessions * 17 participants), and about 50% in the cross-sectional experiment (16 items * 38 participants), not taking into account the long-lasting lexical boost effect of the intervention. Importantly, we believe that our findings are a first step in answering how L2 syntactic representations are acquired in a natural language learning setting, but future studies should include more participants to reach conclusive insights into the process of late L2 learning.

We are aware that our testing method happened in an unconventional manner (i.e., participants were tested at a distance, while being assisted through the phone) due to the COVID-19 pandemic. Although most participants used their personal computer to participate, a few only had a mobile phone at their disposal. This could have caused more noise in the data compared to conventional lab-testing. However, despite the circumstances, our method highlights the robust strength of the structural priming paradigm: the tendency to repeat syntactic structures does not only occur in a lab setting, where participants may be aware of experimental manipulations, but it also occurs in people’s homes, where experimental manipulations may be less apparent.

Our data pinpoints a possible shortcoming of the developmental account (Hartsuiker & Bernolet, 2017), namely that it is based on the residual activation model of Pickering and Branigan (1998). Not only the low proficient speakers, but also the high proficient speakers as well as the native speakers produced more passives after the intervention than before the intervention. So, a few instances of lexical overlap boost the passive structure in subsequent items without lexical overlap between prime and target. The residual activation model does not predict long-lasting lexical boost effects. At the same time, the implicit learning model does not have a straightforward explanation for the lexical boost effect itself (though Chang et al. [(2006]) argue that lexical enhancement effects are due to explicit memory traces of the prime structure). Still, the implicit learning model may predict these effects indirectly, assuming that the items with verb overlap induce stronger explicit memory traces that enhance implicit learning (Chang et al., 2006). Because of the lexical boost effect, participants produced more passives during the intervention items than they would have done in critical items without verb overlap. As a result, the number of passives heard and produced by participants is higher, which may have led to stronger implicit learning. Because of this enhanced implicit learning, they produced more passives after the intervention than they did before the intervention. A bilingual model of L2 development should therefore probably be a hybrid model (cf. Reitter et al., 2011; Momma, 2022; for monolingual hybrid models of structural priming), integrating both implicit learning mechanisms and the residual activation model.

7. Conclusion

Altogether, our results suggest that priming of the active structure takes place before priming of the passive structure, in accordance with our hypotheses. Nevertheless, abstract representations of the passive structure seem to be formed quite rapidly after exposure to the structure. The very early learners, who did not show passive priming, displayed a larger increase in their production of the passive in the intervention block than the learners who had acquired the passive; suggesting that the intervention items with lexical overlap speeded up the formation of abstract representations due to implicit learning. Our results indicate that, ideally, a developmental model of L2 syntax should be a hybrid model, incorporating aspects of the residual activation theory as well as an implicit learning mechanism.

CHAPTER 3

PRIMING TRANSITIVES WITHIN THE L2 AND BETWEEN THE L1-L2 IN DUTCH-SPANISH BILINGUALS: WHEN THE MOST FREQUENT L2 SYNTACTIC ALTERNANT IS NOT THE EASIEST TO LEARN

All data, analysis code, and experimental lists are available at

https://osf.io/zpmg7/?view_only=9953fd405f63440d9680c2a241d02e92

Abstract

Hartsuiker and Bernolet (2017) suggest that, during L2 syntactic acquisition, abstract syntactic representations will first be established within an L2, and eventually, these representations are shared with their L1 counterpart, whenever the syntactic structures are *similar* enough between the L1 and L2 of a bilingual. This process occurs earlier for more frequent structures (actives) than for less frequent ones (passives). However, this may not apply to L2 learners of Spanish with L1 Dutch, since in Spanish, the active structure is morphosyntactically *dissimilar* from the one in Dutch, while the passive is similar between both languages. In a structural priming experiment with within (L2-L2)-language and between (L1-L2)-language trials, we investigated to what extent L2 learners of Spanish would show priming for active and passive structures, and whether a lexically based intervention would boost the production of both transitive structures in subsequent trials. We found passive priming regardless of the prime language; the intervention boosted passive production in subsequent trials without verb overlap. We did not find active priming, but we observed that advanced bilinguals were more likely to produce the morphosyntactically dissimilar Spanish active structure (though not always in a correct way) than less advanced bilinguals. Interestingly, we found that our lexically based intervention boosted the correct usage of the dissimilar L2 active structure. We suggest that structural priming studies should incorporate aspects of the residual activation theory and the implicit learning account to better understand how bilinguals form syntactic representations in the L2 and between the L1-L2, particularly when it concerns the acquisition of dissimilar L2 structures.

Keywords: structural priming, L2 syntactic acquisition, bilingualism, within-and between-language priming, learning dissimilar L2 structures

1. Introduction

Research in syntax acquisition has shown that people learn frequent syntactic structures before they learn less frequent structures (see Ellis, 2002). For instance, children first learn and produce active structures before they do the same for passive structures (passives are learned relatively late, around the age of 3, Messenger & Fisher, 2018). Moreover, late learners of a second language (L2) have been found to learn and retrieve highly frequent L2 structures much faster than low frequent structures, especially when the highly frequent L2 syntactic structure is similar to its L1 syntactic counterpart (Hartsuiker & Bernolet, 2017; Runnqvist et al., 2013). However, what happens in the situation where a highly frequent L2 syntactic structure is *dissimilar* to its L1 counterpart, while the low frequent L2 syntactic alternant is similar in both languages of a bilingual? Do L2 learners first learn and establish a syntactic representation for the similar, but low frequent, L2 syntactic structure because they can directly use their L1 syntactic knowledge to produce this structure? Or, given that L2 learners receive more input from frequent L2 syntactic structures than less frequent ones, do they first establish a syntactic representation for the more frequent L2 syntactic alternant, even if this structure is dissimilar from its L1 counterpart?

In this paper, we investigate whether late learners of Spanish with L1 Dutch have established syntactic representations for active ("*La chica saluda <u>al</u> chico" – "Het meisje groet de jongen*" [The girl greets the boy]) and passive structures in Spanish ("*El chico es saludado por la chica" – "De jongen wordt gegroet door het meisje*" [The boy is being greeted by the girl]) – and to what extent they share these representations with their existing Dutch active and passive representations. Passive sentences in Spanish and Dutch are similar between both languages (i.e., the auxiliary verb *ser* [to be] is followed by a past participle and a prepositional phrase ("*por*"/ "*door*" [by]) denoting the agent), but they are the less frequent transitive alternant. The active structure in Spanish, however, which is the more frequent transitive alternant and the preferred structure, is not morphosyntactically similar to its L1 Dutch alternant. Namely, in the example "*La chica saluda al chico"* – The girl greets the boy, the patient (the boy) is preceded by the direct object marker (DOM) *al*, which agrees with the patient's gender. In Dutch, the DOM does not exist. Because of the difference in the morphosyntactic realization of the active structure in Spanish, beginning learners of Spanish with L1 Dutch might take a while to learn the correct form of the Spanish active structure compared to its passive counterpart. In their developmental account of L2 syntactic acquisition, Hartsuiker and Bernolet (2017) propose that L2 syntactic representations are first established within an L2, and with time, these syntactic representations are shared[1] with their L1 counterpart, whenever the structures in question are similar enough. The relative frequency of syntactic alternants plays an important role during this process, in the sense that syntactic representations are first formed for the most frequent structure (e.g., active) and then for the less frequent one (e.g., passive). In the case of learning Spanish transitives by Dutch-Spanish bilinguals, we might see a different pattern. That is, we might observe that these bilinguals first establish a representation for the passive alternant within Spanish and then between Dutch and Spanish, before they do the same for the active structure in Spanish.

We use the *structural priming* paradigm to investigate to what extent late Dutch-Spanish bilinguals have established syntactic representations for the active and passive structure within Spanish and between Dutch and Spanish. Structural priming is the tendency to repeat previously processed syntactic structures (Bock, 1986), and it is a robust tool which allows researchers to investigate how syntactic representations are accessed during syntactic processing (Pickering & Ferreira, 2008; Mahowald et al., 2016). For instance, speakers have a stronger tendency to use a passive sentence ("The boy is being greeted by the girl") after

[1] "Sharing" entails that there is one syntactic representation, for instance, for passives, which is connected to all transitive verbs in a bilingual's mental lexicon.

hearing a similar structure ("The ambulance is being followed by the truck") than when they have just heard its active counterpart ("The girl greets the boy"), given that they have a representation for the structure in question. We use structural priming because we assume that late Dutch-Spanish bilinguals may not spontaneously produce the correct active structure (i.e., using a direct object marker when this is required) in Spanish, as they might only use a DOM when they are provided with an example structure (i.e., when they are primed). If this were the case, it would imply that these bilinguals have a representation for the Spanish active structure in comprehension, and that they produce it correctly under specific circumstances, such as when they can copy a previously comprehended L2 prime structure to produce a similar L2 target structure. Generally, we expect that, because the passive structure is similar between both languages, passive priming within Spanish and between Dutch and Spanish may be stronger (and occur earlier in beginning L2 learners) than active priming within Spanish. Only when these learners are proficient enough, we expect them to produce more correct active structures, thus increasing the odds for active priming to occur.

Learning L2 Syntactic Representations

Cross-language structural priming (i.e., the influence of recent exposure to a syntactic structure in one language on syntactic processing in another language, see Kootstra & Muysken, 2017) studies have suggested that bilinguals share syntactic representations between languages when syntactic structures are sufficiently similar (Hartsuiker & Bernolet, 2017). For instance, in a cross-language structural priming experiment with Spanish-English bilinguals, Hartsuiker et al. (2004) showed that participants had a stronger tendency to produce English passive sentences ("The dog is being chased by the cat") after they heard a Spanish passive prime sentence ("*El obrero es atendido por el profesor"* [The construction worker is served by the teacher]) than when they heard a Spanish active or intransitive sentence. Hartsuiker et al. suggested that this between-language priming effect was due to a shared syntactic representation of the passive structure between Spanish and English. Consequently, they proposed their bilingual lexical-syntactic model, which is rooted in the residual activation theory (Pickering & Branigan, 1998). Pickering and Branigan assume that priming happens due to short-term residual activation of the lexical representation of a verb (e.g., “to chase”) and the syntactic representation for the structure in which a verb is used (e.g., a transitive structure). Additionally, the link between the lexical representation and the syntactic representation is strengthened when both representations are activated. Because of this, language users have a larger tendency to repeat a prime sentence when there is lexical overlap with the target sentence. This is because the link between the lexical and syntactic representation is temporarily strengthened to a greater degree, which allows more activation to spread to the syntactic representation. This phenomenon is known as the *lexical boost effect* to structural priming (Pickering & Branigan, 1998). In their model, Hartsuiker and colleagues suggested that activation of lexical and syntactic representations in one language induces activation of translation equivalents and shared syntactic structures in the other language of a bilingual, which explains their observed cross-language priming effect between Spanish and English passives (see Van Gompel & Arai, 2018, for a review on cross-language priming in bilinguals).

Hartsuiker et al. (2004) did not find active priming between Spanish and English, even though the Spanish-English bilinguals had already developed a syntactic representation for this frequent transitive alternant. There were two active prime structures in Hartsuiker et al.: active sentences in which the subject comes before the verb and the inanimate object after the verb (similar to the active structure in English: “*El taxi persigue el camion*” [The taxi chases the truck]) and active sentences in which the subject comes after the verb and the inanimate object before the verb (i.e., an OVS structure, a structure not found in English: “*El* *camion lò persigue un taxi*” [*The truck it chases a taxi]). Hartsuiker and colleagues suggest that the absence of active priming could be due to their intransitive baseline condition, which may have served as an active prime instead of a ‘real’ baseline (an intransitive uses active voice). Because Hartsuiker et al. argue that similar word order between the Spanish passive and English passive is important for cross-language priming to take place, it is likely that they did not find active OVS cross-language priming since there is no (similar) English counterpart available in the bilingual’s memory. In terms of the absence of active SVO priming, which has a similar structure in English, there could be another explanation which resides in *the implicit learning account* (Chang et al., 2006). Unlike the residual activation theory, which provides an explanation for short term-structural priming and the lexical boost effect, the implicit learning account suggests that structural priming reflects a long-term learning process. According to Chang et al., structural priming effects arise due to error-based learning of syntactic rules, in which learning depends on the difference between syntactic predictions and actual syntactic structures encountered during processing. This learning process is influenced by the relative frequency of syntactic structures, such that less frequent syntactic structures (e.g., passives) induce a larger prediction error than more frequent structures (e.g., actives). For priming effects, this entails that low frequent structures give rise to stronger priming effects than high frequent structures, a phenomenon that has been coined the *inverse frequency effect* to structural priming (Jaeger & Snider, 2013; Hartsuiker & Westenberg, 2000; Ferreira & Bock, 2006). This may explain why Hartsuiker et al. did not find active priming between Spanish and English (the same effect is also found within languages: Hartsuiker and Kolk (1998) found passive priming within Dutch but no active priming). Thus, from the study of Hartsuiker et al., it seems that cross-language priming of passives occurred because of the shared passive representation between Spanish and English. Moreover, the lack of syntactic similarity between the Spanish OVS active structure and the

English active structure may explain why the researchers did not find cross-language priming between these two structures. Also, given the predictions of the implicit learning account, the relative frequency of both transitive alternants may have played a role in the absence of active SVO priming.

Next to syntactic similarity and the relative frequency of a structure, it has been found that L2 proficiency also plays a role in the priming of syntactic structures within an L2 and between the L1 and L2. For instance, Bernolet et al. (2013) demonstrated that higher proficiency L2 speakers of English with L1 Dutch were primed stronger for genitives (S-genitives: “the girl’s shirt” and Of-genitives: “the shirt of the girl”) than lower proficiency speakers. This suggest that the highly proficient speakers had established stronger representations for genitives than the less proficient ones. Genitives are not always similar in Dutch and English, as they differ slightly in the morphosyntactic realization of the S-genitive. Dutch and English both have the S-genitive, where the possessive morpheme – ‘s is used, but this variant is limited to proper nouns (e.g., *Noa’s schoenen* – Noa’s shoes) and common nouns (e.g., *moeders schoenen* – mother’s shoes). However, in spoken varieties, the second form of the S-genitive (e.g., *Het meisje haar schoenen* - *The girl her shoes) is not similar to the English equivalent since a possessive pronoun is used (e.g., *haar* - her) instead of the possessive morpheme – ‘s. In contrast, the Of-genitive is always similar in both languages (*De schoenen van het meisje* – The shoes of the girl). Because the Dutch S-genitive is not always similar to the one in English, Dutch-English bilinguals might take a while to realize that the syntactic representation for the Dutch S-genitive can be shared with the one in English. Bernolet et al. found stronger abstract structural priming (i.e., priming with no verb overlap) for the S-genitive (*Het meisje haar schoenen* – The girl’s shoes) between the L1 and the L2 upon increasing proficiency. This suggests that the highly proficient learners had established a shared syntactic representation between the Dutch S-genitive and the English S-genitive. Interestingly, the researchers noted that the higher proficiency bilinguals made more syntactic errors while producing the S-genitive compared to the lower proficiency bilinguals. These errors consisted of syntactic transfer errors such as *The girl **her** shoes [correct in Dutch: "*Het meisje haar schoenen*" – The girl's shoes]. It is possible that the sharing of the S-genitive structure between Dutch and English might have caused these syntactic errors to happen. Unlike the highly proficient bilinguals, the low proficient bilinguals did not show abstract priming for the S-genitive. In fact, the low proficient speakers only produced S-genitives at the beginning of the experiment, which implies that they might have been hesitant to continue to use the S-genitive throughout the experiment, making S-genitive priming less likely to occur.

In their within-language experiment, Bernolet et al. (2013) found that the lower proficiency bilinguals showed greater benefits from lexical overlap between prime and target sentences (specifically, S-genitive constructions) than the higher proficiency bilinguals. It appears that lower proficiency speakers rely on item-specific representations, and perhaps even more when the L1-L2 structure is dissimilar. This finding is in line with Kim and McDonough (2008), who report that lower proficiency bilinguals use lexical repetition as a memory cue to produce a similar syntactic (target) structure. From these results, it seems that L2 learners start with non-shared, item-specific syntactic representations in their L2, which become abstract and shared between the L1 and L2 as second language proficiency increases.

Following the work from Bernolet et al. (2013), Hartsuiker and Bernolet (2017) propose that, during the acquisition of L2 syntax in late L2 learners, abstract syntactic representations will first be established for syntactic structures that are similar between languages, and this will happen earlier for more frequent structures than for less frequent ones. Moreover, the level of L2 proficiency plays a role during this abstraction process, such that advanced bilinguals are more likely to have developed syntactic representations for complex structures (e.g., passives) than less advanced bilinguals. However, Hartsuiker and Bernolet's developmental account for L2 syntactic acquisition is not clear about what happens when the dissimilar L2 syntactic alternant (e.g., due to morphosyntactic differences between the L1 and the L2) is the more frequent syntactic alternant (e.g., the active form in Spanish: *"La chica saluda al chico" – "Het meisje groet de jongen"* [The girl greets the boy]), while the similar L1-L2 alternant is the less frequent one (e.g., passives in Spanish and Dutch: "*El obrero es atendido por el profesor" – "De bouwvakker wordt geserveerd door de leraar"* [The construction worker is served by the teacher]). In this case, is it more likely that low proficient bilinguals only show priming for the L1-L2 similar, but less frequent, structure, while highly proficient bilinguals also show priming for the dissimilar, but more frequent, L2 structure? We investigate this question with Spanish transitives in Dutch-Spanish bilinguals, who have varying proficiencies in Spanish. Furthermore, since passive sentences are not commonly used in Spanish (native speakers generally consider them to be more formal, according to Flett, 2003), we will investigate whether priming effects can be found for both active and passive structures in this language.

Present study

Our study examines whether late learners of Spanish with L1 Dutch, who have varying levels of Spanish proficiency, demonstrate structural priming effects for active and passive sentences both within Spanish ("*La chica saluda al chico*" – "*Het meisje groet de jongen*" [The girl greets the boy]) and between Dutch and Spanish ("*El chico es saludado por la chica*" – "*De jonger wordt gegroet door het meisje*" [The boy is being greeted by the girl]). Thus, we investigate within- and between-language priming within the same participants. Importantly, we use a baseline condition to determine to which extent active and passive priming takes place, relative to this baseline. To assess the participants' proficiency in

Spanish, we administered the Spanish LexTALE language test (Izura et al., 2014) and used the scores to examine how L2 proficiency plays a role in the priming of Spanish transitives.

Active sentences in Spanish are morphosyntactically different from actives in Dutch when the subject and direct object concern animate objects (AA items – "*El obrero ayuda* <u>*a la*</u> *médica" –* "*De bouwvakker helpt de dokter"* [The construction worker helps the doctor]), due to the direct object marker (DOM) "a la", but are similar when the subject and direct object concern inanimate objects (II items – "*El camión persigue el coche" –* "*De vrachtwagen volgt de auto"* [The truck chases the car][2]). The required DOM in the first sentence must agree with the gender of the direct object. Thus, when the direct object is masculine, one must use "*al"* ("*El obrero ayuda* ***al*** *profesor*" – The construction worker helps the teacher), which is a contraction of *a* and *el*. Unlike the active structure in Spanish, the passive structure is syntactically similar to the one in Dutch, though the learner has to pay attention to gender agreement in the past participle. If the patient is feminine, the past participle[3] ends with "-ada" ("*La médica es* <u>*salud**ada***</u> *por la cantante*" [The doctor is greeted by the singer]); if the patient is masculine, the past participle ends with "-ado" ("*El panadero es* <u>*llev**ado***</u> *por la periodista*" [The baker is carried by the journalist]).

We assume that Dutch-Spanish bilinguals might show a different priming pattern for Spanish transitives in within-language trials (Spanish primes – Spanish targets) compared to between-language trials (Dutch primes – Spanish targets). Because the syntactic structure of the Dutch passive can be directly mapped onto the structure of the Spanish passive, producing Spanish passive sentences might be easier for beginning learners (i.e., less

[2] In Spanish, for II-items, one may also use a direct object marker (DOM), but this is not required. Thus, the sentence "*El camión persigue* ***al*** *coche*" is also grammatically correct, similar to "*El camión persigue* ***el*** *coche*". In this experiment, however, we did not use a DOM in our II prime-items, because we wanted to highlight the difference between II and AA items.

[3] To form the past participle of regular verbs in Spanish, the infinitive ending is dropped (-ar, -er, -ir) and -ado[a] is added to the stem of -ar verbs (e.g., saludar – saludada [feminine]/saludado [masculine]); -ido is added to the stem of -er and -ir verbs (e.g., perseguir – perseguida [feminine]/perseguida [masculine]).

proficient speakers) of Spanish compared to producing active sentences[4]. Given the predictions of Hartsuiker and Bernolet (2017), we anticipate that low proficient bilinguals may only show passive priming within Spanish and between Dutch and Spanish, due to the syntactic similarity of passives in both languages. On the other hand, higher proficiency bilinguals are expected to demonstrate active priming, primarily within the L2, as well as passive priming in both the L2 and between the L1 and L2. More specifically, highly proficient Dutch-Spanish bilinguals may be more likely to produce the correct form of the active structure in Spanish, probably due to an increased L2 exposure, than low proficient bilinguals. As a result, we anticipate that active priming within Spanish may only be observed in higher proficiency L2 speakers. In contrast, lower proficiency bilinguals might directly translate the word order of Dutch actives to Spanish (*De bouwvakker helpt de dokter* - **El obrero ayuda la médica* [The construction worker helps the doctor]), which leads to an ungrammatical Spanish sentence[5], and thus decreases the likelihood of active priming to occur.

In the experiment, we aim to make the learners, especially the lower proficiency ones, aware of the different realizations of the active structure in Spanish, and we also aim to encourage participants to produce the passive structure in the between-language trials. For these reasons, in the middle of our structural priming experiment, we inserted an intervention block, which consists of four trials with verb overlap between prime and target sentences (see Van Lieburg et al., see Chapter 2; Muylle, 2021b for the same experimental manipulation). There were two active primes in Spanish and two passive primes in Dutch. Given that the active structure in Spanish is likely to be frequently produced incorrectly, we hypothesize that

[4] Of course, one may argue that an active sentence will always be easier to produce for beginning L2 learners due to its shorter length and less complex structure. Here, ‘easier’ means that we believe that the number of grammatically correct passive sentences may be higher than the number of grammatically correct active sentences. If a DOM is required in an active sentence, but it is not used, the active sentence is grammatically incorrect.
[5] “Ungrammatical” refers to the syntactic error that occurs at the morphosyntactic level.

the intervention block's verb-overlap items could help learners to produce more accurate active sentences after the intervention than before. Across all levels of proficiencies, we also expect to find stronger passive priming after the intervention block than before the intervention block.

Research has shown that native Spanish speakers rarely use the passive structure spontaneously and tend to exhibit weaker passive priming compared to L2 speakers (Flett, 2003). Therefore, we also included native speakers of Spanish in our study. To our knowledge, there is little evidence for the priming of transitive structures within Spanish native speakers. For the sake of comparison and completeness, we deemed it important to first report the structural priming pattern of active and passive structures in native speakers before reporting the pattern in late learners of Spanish. Moreover, because we assume that late learners of Spanish will probably make many syntactic errors during the formulation of active sentences (see above), it is important to investigate the production of active sentences in native speakers too, as they will probably make fewer errors in actives.

2. Experiment 1: Spanish Native Speakers

2.1 Method

2.1.1. Participants

Thirty native speakers of Spanish participated in this study, and they all resided in Spain (in the Basque country, Madrid, and Barcelona). The participants were between 18-52 years old[6] (M=25.8, SD=9.17, 95% CI [22.37, 29.23]). There were 25 females and 4 males, and one participant did not provide their gender. Most native speakers (28 participants) spoke Basque and English as their second and third language, respectively. There were two participants

[6] We decided not to use an age restriction for this study because native speakers, residing in Spain, were difficult to find, especially ones within a specific age range. Also, we asked participants to record themselves (see *Procedure*) and this required more time and effort from participants.

who did not speak another language next to their L1. All participants provided written consent for their participation and received a gift voucher in exchange for their participation.

2.1.2. Stimuli and Design

The native speakers performed a within-language (Spanish primes - Spanish targets) structural priming experiment. We used 1,064 color drawings in the experiment (we used the same drawings for a previous structural priming experiment involving late learners of Dutch, Van Lieburg et al., see Chapter 2). The materials were specifically drawn for beginning L2 learners who do not have an extensive vocabulary in their second language. All materials are available online [https://osf.io/zpmg7/?view_only=9953fd405f63440d9680c2a241d02e92]. The nouns that appeared in our materials consisted of eight professions (animate entities) (e.g., a baker, a construction worker) and eight vehicles (e.g., an ambulance, a firetruck). For the pictures with animate entities, we chose six transitive verbs: *to greet*, *to call*, *to help*, *to serve*, *to phone*, and *to carry*. Similarly, for the pictures with inanimate entities (e.g., a bus and a tram), there were six different verbs too: *to hit*, *to pass*, *to block*, *to replace*, *to drag*, *to follow*. There were twelve intransitive verbs for the filler trials that had animate entities (e.g., *to smile*, *to cry*) and twelve intransitive verbs for the pictures with inanimate entities (e.g., *to park*, *to stop*). The drawings were set up such that each profession and each vehicle occurred as an agent and a patient and each verb was equally divided across prime sentences and target pictures, while avoiding lexical overlap between the prime and target sentences. As the materials were adjusted to the vocabulary knowledge of late L2 learners, the items were probably too easy for the native speakers of Spanish.

2.1.2.2. Design

The within-language (Spanish – Spanish) structural priming experiment consisted of audio prime sentences, a verification task, and target description pictures. There were 144 prime sentences, 48 were critical prime sentences, divided over three conditions: the active ("*El panadero ayuda a la cantante"* [The baker helps the singer]), the passive ("*La cantante es ayudada por el panadero*" [The singer is being helped by the baker]) and a baseline condition, which consisted of conjoined noun phrases (*el panadero y la cantante* [the baker and the singer]). We included a baseline to determine the production preferences of the native speakers in unprimed conditions and to investigate to what extent active and/or passive priming would occur relative to the baseline condition (see Bernolet et al., 2009). In the middle of the experiment, we inserted an intervention block with four trials (active sentences) that repeated the verb between the prime and target sentence[7]. The remaining 92 sentences were filler sentences. The fillers consisted of prime sentences with intransitive verbs and target pictures that depicted an intransitive action. The prime sentences were recorded into separate audio files by a native speaker of Spanish.

The verification task, which functioned as a distraction task, was presented simultaneously with the prime trials. In the prime trials, the native speakers were exposed to an audio recording of the prime sentence. Simultaneously, they saw two pictures: the correct picture that matched the prime sentence and a competitor picture. For instance, if participants would hear the prime sentence "*El panadero saluda al médico"* (The baker greets the doctor) they would see two pictures. In the correct target picture, the agent is "the baker" and "the

[7] The intervention block for the native speakers only consisted of *active* sentences. There were no passive sentences because this experiment was based on a previous experiment in which we initially aimed to prime the active OVS structure and the active SVO structure. We did not pursue the initial experiment, and the intervention block items were changed to only active SVO structures. We acknowledge that the intervention block should have included passive sentences to better investigate the effect of a lexically based intervention on passive priming in subsequent trials without verb overlap.

doctor" is the patient; and in the competitor picture, the agent is "the doctor" and the patient is "the baker". The competitor picture could either be described with an active sentence "*El médico saluda al panadero*" (The doctor greets the baker) or with a passive sentence "*El panadero es saludado por el médico*" (The baker is being greeted by the doctor). We included the verification pictures to test whether participants would interpret the first noun as an agent (active interpretation) or as a patient (patient interpretation). The verification for the filler trials consisted of the same object in the correct and competitor picture, but the verb was different in the two pictures. For instance, if a participant heard the sentence "*El panadero habla*" (The baker talks), the competitor picture would portray, for example, a baker smiling. We manipulated the position of the correct picture and its competitor (i.e., on the left or on the right side of the screen) within each prime item across our experimental lists.

As critical target pictures, we employed 48 pictures together with Spanish transitive verbs that had to be used to describe them. We did not repeat the verb of the prime sentence in these 48 target pictures. In this way, we tested abstract structural priming (Pickering & Ferreira, 2008). Recall that the four target pictures in the intervention block repeated the verb of the prime sentence. We counterbalanced the position of the patient within items across our experimental lists, such that the production of passive sentences could not be related to the position of the patient. Additionally, there were 92 filler target items, which could be described with an intransitive verb. The target Spanish verbs were displayed at the bottom of the pictures and participants were told to conjugate the verb to produce a sentence.

The prime-target pairs were pseudorandomly mixed with the filler items, with the constraint that the experiment started with three filler items. We used the same four trials in the intervention block across all experimental lists. Each prime and target pair was followed by one, two or three filler items. We created 12 experimental lists for this experiment. The first six lists were constructed based on the three prime conditions and the counterbalanced position of patient in the target pictures (e.g., lists 1 and 4 had the same prime condition, but if the patient of the target image occurred on the right side in list 1, the patient of that same target image occurred on the left side in list 4). The last six lists were the same as the first six lists in terms of the prime condition and the patient position in each target picture, but we switched the order in which the items occurred. That is, items that occurred before the intervention in the first six lists, occurred after the intervention in the last six lists (and items that occurred after the intervention in the first six lists, occurred before the intervention in the last six lists). We did this to account for within-item variance that may have been affected by the intervention block.

The experiment was programmed in *PsychoPy* v.3.4 (Peirce et al., 2019) and was run on the online platform Pavlovia. The Pavlovia experiment was embedded in a Qualtrics (Qualtrics, Provo, UT) survey, which contained the instructions, the request to provide informed consent and some demographic questions (age, gender, language background).

2.1.3. Procedure

The participants participated remotely, like the non-native speakers (see 3.1.3). The link to the study, which directed participants to a Qualtrics survey, was distributed through colleagues teaching at different universities (Basque Country, Madrid, and Barcelona) in Spain. Once participants had given their consent to participate, they read the instructions to the study. They were told that, during the experiment, they would be listening to short sentences in Spanish and that they would be verbally describing pictures in Spanish. During the instructions, participants were informed that they had to record the sentences they produced during the experiment for the researchers to identify the target structures.

The audio prime sentence described only one of the two pictures (the target picture or the competitor picture) that participants saw on their screen. While listening to the audio prime sentence, participants had to click on the picture that matched the prime sentence. After participants clicked on the picture, they saw a 'speaking' symbol. This speaking symbol was accompanied by a Spanish flag, which was placed underneath the symbol, indicating that they had to verbally describe the next picture using a Spanish sentence. Subsequently, participants saw the target picture with the main verb placed underneath it; they had to formulate a sentence.

After the priming experiment, participants were presented with a short language questionnaire. During this questionnaire, they were asked to provide general demographic information (their gender, age); what language(s) they spoke; and they had to rate their proficiency in all the languages they spoke (in production as well as in comprehension), and they had to guess the goal of the study. At the end, participants were reminded to e-mail the audio file of their recorded sentences to the researchers. The native speakers took about 20 to 30 minutes to complete the study, and they received a voucher for their participation by e-mail. In this e-mail, we provided them with the opportunity to contact us if they had questions about the goal of the study.

2.1.4. Coding

The responses were manually coded as active, passive, or "Other" responses. A response was coded as an active sentence if the agent of the transitive event was mentioned first, followed by a conjugated verb, a direct object marker (*a la* or *al*: when this is required for AA-target items), and the patient. If native speakers did not use a DOM in AA-target items, we coded this as an incorrect active response. We did not include these incorrect active responses in the analysis below (2.1.5.). Passive responses were coded when the patient was mentioned first, followed by the auxiliary verb (*ser* [to be]), the past participle and if the sentence ended with a prepositional *by*-phrase using the preposition *por* (by). So, for instance, a correct passive response would be: *El autobús es perseguido por la bicicleta* - [The bus is being followed by the bicycle]. Recall that native Spanish speakers rarely use the passive form during spoken language. In Spanish, there is another, more common way of using a passive, namely, the passive “se” or the “pasiva refleja”, which is denoted with the reflexive pronoun *se* (e.g., “*Se habla inglés en muchos países*” - “*Er wordt Engels gesproken in veel landen*” [English is spoken in many countries]). Though more common, we did not prime this passive form, and participants very rarely used this structure (e.g., “*El camion de bomberos se remolca*” – The firetruck is towed) (see below 2.2. Results). We did not include “pasiva refleja’s” in our analysis. In addition, “Other” responses were coded when participants formulated an ungrammatical sentence, such as when they left out the patient in the description of the target sentence. This omission often occurred when participants moved on too quickly to the next trial. For example, a participant might say “la periodista saluda a la...” instead of “la periodista saluda a la carnicera” [the journalist greets the butcher]. “Other” responses were also coded when participants used a present progressive tense, which requires the auxiliary verb “estar” (to be) and a present participle (verbs that end in -ando or -iendo) (e.g., “*La medica esta llamando al obrero*” [The doctor is calling the server]). This was because there is no passive counterpart available for this sentence.

2.1.5. Analysis

We fit the active and passive target responses (with actives as the reference level) to generalized linear mixed effect models as implemented in the *lme4* package (Bates et al., 2015), with a Bobyqa optimizer to increase convergence (Powell, 2009) in *R* (R Core Team, 2020, version 4.1.2.). Our maximal model consisted of the predictors *Prime Condition* (baseline, active and passive, with the baseline condition as reference) and *Intervention* (pre-vs. post-intervention, with pre-intervention as the reference level) and their interaction. Following the suggestions of Barr et al. (2013), we added random slopes and random intercepts for *Participant* and *Item*. We report the *beta* estimates and the R^2 values of the final model (as estimated by the *report* package), as these are measures of effect size (Lorah, 2018). We used an alpha level of .05 for interpreting statistical significance.

The full model was simplified in a stepwise way due to convergence and singularity issues. We removed random slopes for *Item* before removing any random slopes for *Participant* (the variance in items is usually smaller than in participants, Segaert et al., 2016). After simplifying the random effects part of the full model, only random intercepts for *Participant* and *Item* remained in the final model. The fixed effects part of the model was not further simplified, as there were no longer convergence or singularity issues.

2.2. Results

We collected 1,560 target responses to the prime sentences from the native Spanish speakers. There were 1,295 active sentences (83%), of which 1,255 were correct and 40 were incorrect (i.e., when a DOM was required but not used). There were 131 passive responses (8.40%), and only 6 responses were “pasiva refleja’s” (0.39%); 96 responses were ‘Other’ (6.15%); and there were 32 missing trials (trials where no response was provided) (2.05%). We deleted the incorrect active responses, “pasiva refleja’s”, all “other” responses and missing trials from further analysis. After this, 1,386 observations remained in our dataset, which consisted of only correct active responses (1,255) and passive responses (131). Figure 1 presents the proportion of active and passive responses after each prime condition.

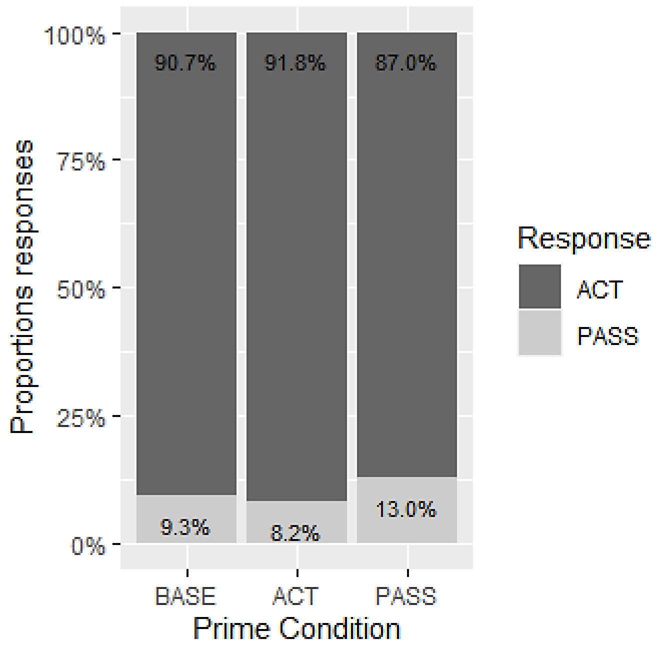


Figure 1 The proportion of primed responses in the native speakers. The dark shade of grey indicates the active responses and the lighter one displays the passive responses.

Table 1 presents the output of the final model, which consisted of an interaction between *Condition* and *Intervention* and random intercepts for *Participant* and *Item*.

Table 1 Summary of the fixed effects in the multilevel logit final model

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	-3.59	0.43	-8.32	<.001
Prime Condition ACT	0.28	0.39	0.72	0.472
Prime Condition PASS	0.78	0.37	2.10	**0.035**
Intervention (post-intervention)	0.83	0.37	2.24	**0.025**
Prime Condition (active): Intervention (post-intervention)	-0.91	0.52	-1.74	0.082
Prime Condition (passive): Intervention (post-intervention)	-0.63	0.48	-1.29	0.195

Note. Final model = glmer(target response ~ Prime Condition * Intervention (1|Participant) + (1|Item), data = native speakers, family = binomial)

The model's intercept corresponds to the baseline condition and the pre-intervention block as reference levels. The target response is binary (active vs. passive, with active as reference level). The intercept suggests that the native speakers produced significantly more actives in the baseline condition compared to passives (b = -3.59, 95% CI [-4.43, -2.74], p < .001). We did not find active priming (b = 0.28, 95% CI [-0.49, 1.05], p = .472), but there was significant passive priming (more passives after a passive prime condition compared to passives after a baseline condition) (b = 0.78, 95% CI [0.05, 1.51], p = .035). In addition, more passives were produced after the intervention block than before the intervention block (b = 0.84, 95% CI [0.11, 1.57], p = .025). The interaction between active priming and *Intervention* was not significant (b = -0.91, 95% CI [-1.93, 0.11], p = .082), though the trend suggests that the use of actives was boosted in subsequent trials that did not have verb overlap. We did not find a significant interaction between passive priming and *Intervention* (b = -0.63, 95% CI [-1.57, 0.32], p = .195).

We stress that, in the priming experiment for the native speakers, the intervention block consisted of only *active* sentences with verb overlap between prime and target sentences. The effect of *Intervention* suggests that there was a significant increase of passives in the post-intervention block compared to passives in the pre-intervention block. However, it is unlikely that this increase is due to the prime-target *active sentences* in the intervention block. We believe that the increase of passives after the lexically based intervention may have been due to either cumulative priming (structural priming effects that accumulate across prime trials, see Kaschak et al., 2014) or self-priming (structural priming effects that occur because of one's own syntactic target productions, see Jacobs et al., 2019). However, because the post-intervention items are affected by the intervention block, and because cumulative priming or self-priming may have played a role in the increase of passives, it was still difficult to investigate whether the increase of passive production could have been solely due to cumulative priming or self-priming effects. In other words, given that the post-intervention items were affected by the intervention block itself, it was difficult to test for cumulative priming and self-priming effects throughout the experiment, as the source of the increase in passives after the intervention may stem from several factors.

2.3 Discussion

From the results, it seems that the Spanish native speakers demonstrate passive priming. As far as we know, only Flett (2003) has reported passive priming in native Spanish speakers, but she compared this effect to passive priming in L2 speakers, who showed stronger passive priming than the native speakers did. Because the use of passives is less preferred than the use of actives (and even more so in native speakers of Spanish), this result is in line with the inverse-frequency effect. This is because the least preferred structure incites the strongest priming effect.

It is true that the significant effect for *Intervention* did not provide us with valuable insights due to the design of our study: the increase of passives cannot be explained by the intervention since it only consisted of actives with verb overlap. We observed a trend towards a significant interaction between *Intervention* and active priming, which suggests that a few trials with verb overlap in the same structure may boost active production in the following trials without verb overlap, even though the use of actives is almost at ceiling. Further studies would be required to test the effects of a lexically based intervention; and perhaps such an intervention may also boost the use of frequent structures too (see Van Lieburg et al., Chapter 2, who found that a lexically based intervention boosts the production of passives in native Dutch speakers, even though these speakers have already established a firm representation for passives).

3. Experiment 2: Dutch-Spanish bilinguals

3.1. Method

3.1.1. Participants

Thirty-nine late learners of Spanish with L1 Dutch participated in the second part of this study. We recruited more learners than native speakers, as we were particularly interested in L2 proficiency effects on our predictors (an interaction requires more participants, see Mahowald et al., 2016). The participants were between 18-70 years old[8] (M=31.54, SD=14.63, 95% CI [26.79, 36.28]). There were 32 females and 7 males. The learners had acquired Spanish at different language learning centers, in online language classes, in secondary school or at university. There were 12 participants who indicated that they spoke Spanish at A1 level, 9 spoke Spanish at A2 level, 5 at B1 level, 8 at B2 level, 4 at C1 level, and there was 1 participant who indicated that they had a C2 level command of Spanish. The mean LexTALE score is 60.51%, and this corresponds to a B1/B2 level (lower intermediate/upper intermediate level, see Lemhöfer & Broersma, 2012). The learners had been learning Spanish for a minimum of 2 months[9] and a maximum of 48 months. Table 2 summarizes the most important features of the learners.

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[8] We decided not to use an age restriction for this study because late L2 learners of Spanish with L1 Dutch within a specific age range (e.g., 18 – 35 years) were difficult to find. Specifically, we asked participants to record themselves (see *Procedure*) and this required a considerable amount of time and effort from participants. For this reason, we allowed much variation in the age of the participants.

[9] This may be considered a short amount of time. There were 4 participants who were learning Spanish for just two months at the time of testing. They produced mostly only active sentences, but, as expected, these were almost always ungrammatical (i.e., leaving out a DOM).

Table 2 Profile of the Dutch-Spanish Bilinguals

	M *(SD)*	95% CI [,]	Range
Dutch-Spanish learners (N=39)			
Age	31.54(14.63)	[26.79, 36.28]	18 -70
Age of Spanish Acquisition	29.33(15.28)	[24.38, 34.28]	12 - 68
Duration of Spanish language course (in months)	14.03 (11.05)	[10.44, 17.61]	2 - 48
Spanish-LexTALE score	60.51 (14.71)	[55.74, 65.28]	23.33 – 92.50

3.1.2. Stimuli and Design

3.1.2.1. Stimuli

The learners of Spanish performed a structural priming experiment that had within-language (Spanish primes - Spanish targets) trials and between-language (Dutch primes – Spanish targets) trials. We used the same materials as in Experiment 1.

3.1.2.2. Design

The design of Experiment 2 was largely similar to Experiment 1. However, the prime sentences (144 primes) were equally divided into six blocks of within-language trials (Spanish primes - Spanish targets) and six blocks of between-language trials (Dutch primes-Spanish targets), which were alternated throughout the experiment. This means that each list either started with a within-language block or a between-language block (there were 12 lists). The intervention block in Experiment 2 was different from the one in Experiment 1: two of the four trials were in the between-language condition and both primes were passive sentences (with verb overlap); the other two intervention items were in the within-language condition, and both were active sentences (with verb overlap). Recall that we aimed to make the learners, especially the lower proficiency ones, aware of the different realizations of the active structure in Spanish. Moreover, we also aimed to encourage the learners to produce the passive structure in the between-language trials, as the passive is similar in Dutch and Spanish. Another difference between this experiment and Experiment 1 is that we asked a native speaker of Dutch to record the primes for the within-language blocks and a learner of Spanish with L1 Dutch to record the primes for the between-language blocks. We chose for an L2 learner of Spanish because a native speaker of this language would pronounce words "too nativelike", which deviates from how the learners pronounce Spanish words themselves (see Lagrou et al., 2011).

3.1.3. Procedure

The procedure of Experiment 2 was similar to that of Experiment 1. We recruited the learners through Spanish language teachers at different Flemish universities, through language learning centers, and through social media. The learners listened to either Spanish or Dutch prime sentences but had to always use a Spanish sentence to verbally describe the target pictures. During the experiment, we indicated which language participants would hear per trial with either the Spanish flag or the Dutch flag (the prime language remained the same within each block).

Unlike in Experiment 1, participants performed the Spanish LexTALE language test (Izura et al., 2014) after they had completed the priming experiment. After the LexTALE, participants were presented with a short language questionnaire. Next to providing general demographic information, we asked participants to indicate how long they had been learning Spanish, and at what level they were learning Spanish. The learners took 45 minutes to an hour to complete the study.

3.1.4. Coding

We coded the data for the learners with two different coding schemes: a lenient coding scheme and a coding scheme for the active responses only (see 4.1.1. below). We applied a lenient scoring scheme to investigate the priming of active and passive sentences. This scheme allowed all responses that showed a general understanding of how an active and a passive structure should be formed in Spanish, even if they contained mistakes such as the omission of a direct object marker or an incorrect inflection. Concretely, for actives, this means that we included all forms of the active structure (i.e., it did not matter whether participants used a direct object marker or not). Thus, an active response was coded if the agent of the transitive event was mentioned first, followed by a conjugated verb, (the direct object marker *a la* or *al*), and the patient. Passive responses were coded when the patient was mentioned first, followed by the auxiliary verb *ser*, which translates into "to be" in English, a form of the past participle and if the sentence ended with a prepositional *by*-phrase using the preposition *por* (by). So, for instance, a correct passive response would be: "*El autobús es perseguido por la bicicleta"* [The bus is being followed by the bicycle]. We allowed all attempts of the past participle (i.e., if participants did not conjugate the past participle in agreement with gender). As we tested learners with varying levels of Spanish proficiency, we assumed that not everyone would conjugate the past participle correctly. "Other" responses were coded if participants formulated an ungrammatical sentence (e.g., leaving out the patient in active sentences: "*La moto adelanta*" [*The motor overtakes]) or when participants produced short passives (a passive form in which the patient is not overtly realized: "*El autobús es perseguido"* [The bus is being followed]).

3.1.5. Analysis

We applied the same analysis as in Experiment 1. Our maximal model consisted of the predictors *Prime Condition* (baseline, active and passive, with the baseline condition as reference), *Prime Language* (within vs. between, within as the reference level), *Intervention* (pre- vs. post-intervention, with pre-intervention as the reference level), *L2 Proficiency* (obtained from the raw scores of the LexTALe test), as well as their interactions. Thus, the full model consisted of a four-way interaction *Prime Condition* * *Prime Language* * *Intervention* * *L2 Proficiency*). Since *L2 Proficiency* is a continuous covariate, this variable was scaled and centered before it was entered into our models. Following the random effect structure as proposed by Barr et al. (2013), we added random intercepts and random slopes for *Participant* and *Item*.

Like in Experiment 1, we first simplified the random effects part of our model. The final random effects part of the model consisted of only *Participant* and *Item* as random intercepts. Dissimilar to Experiment 1, however, we had to further simplify the fixed effects part of our full model due to singularity issues. We did this by testing which interactions were not significant; for this, we used the *drop1* function from the basic stats package in *R*. Only the two-way interaction between *Prime Condition* and *L2 Proficiency* remained in the fixed effects parts of our final model.

3.2. Results

In total, we collected 2,028 target responses to our prime sentences from the Dutch-Spanish bilinguals. There were 1,584 active responses (78.1%) (this included correct and incorrect active forms), 206 responses were passives (10.2%), 236 responses were “Other” responses (11.6%) and there were two missing trials (0.01%) (i.e., trials with no response). We deleted

“Other” responses and missing trials for further analyses. After this, 1,790 responses remained in our dataset. Figure 2 shows the proportion of active and passive responses per prime condition, and prime language in the pre-and post-intervention. The bar plots of the within-language condition indicate that, post-intervention, passive responses were more often produced in the passive prime condition compared to the baseline, which suggests passive priming. The bar plots of the between-language condition illustrate a rather different pattern in the post-intervention condition: though the proportion of passives increases in all conditions, participants produced *fewer* passives in the passive prime condition than in the baseline condition, which suggests *negative* priming. Figure 3 shows the proportion of passive and active responses during the intervention block in the within- and between-language condition: as expected, actives were almost always produced in the within-language trials and passives were more often produced in the between-language trials.

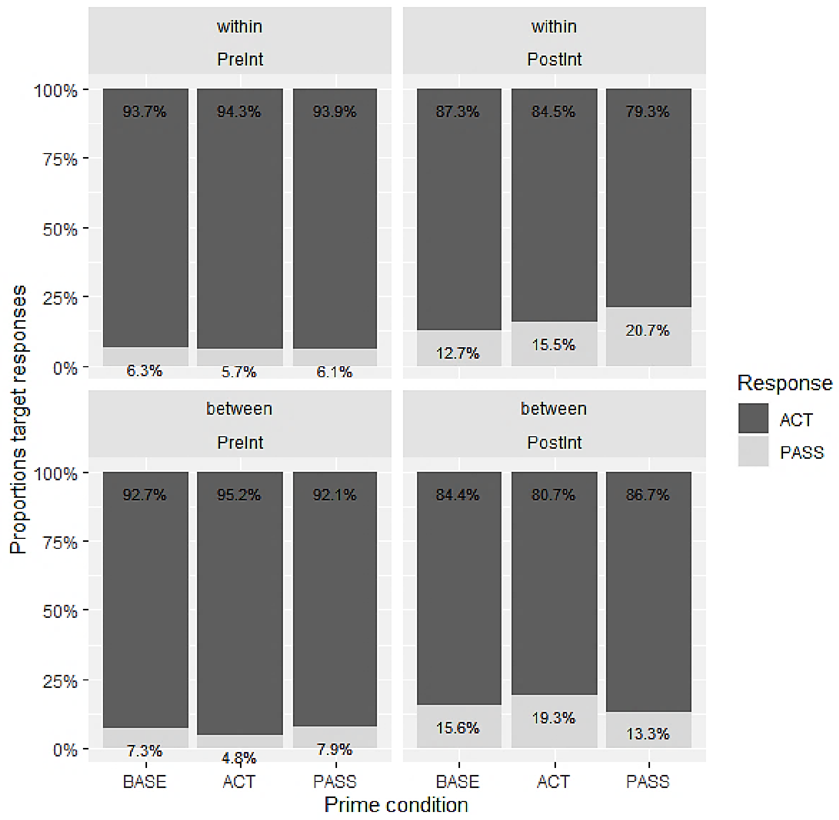

Figure 2 The proportion of actives and passives per prime condition before the intervention and after the intervention in the within-language condition (upper two bar plots) and in the between-language condition (lower two bar plots).

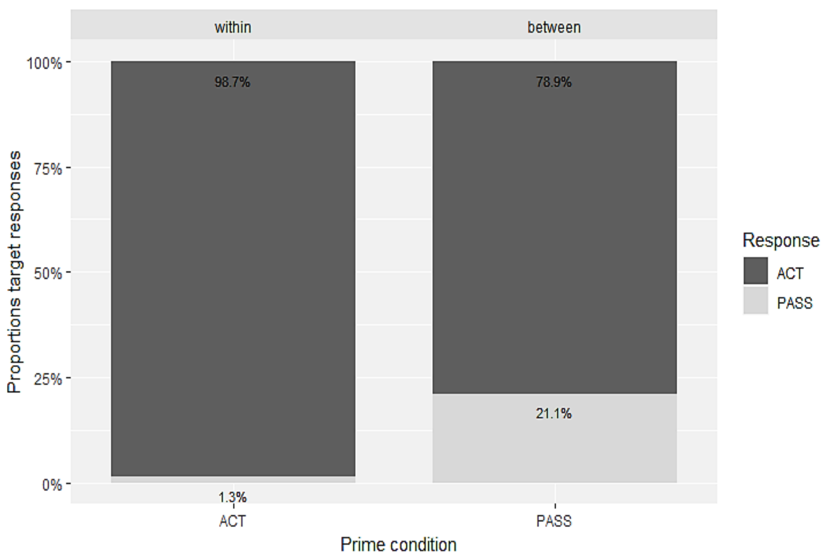

Figure 3 Proportion of active and passive responses in the intervention block, divided between within-language trials (i.e., only actives were primed) and between-language trials (i.e., only passives were primed).

Table 3 below displays the final model for the L2 learners of Spanish, which consisted of an interaction between *Prime Condition * L2 Proficiency*, the predictors *Prime Language* and *Intervention*, and random intercepts for *Participant* and *Item*.

Table 3 Summary of the fixed effects in the multilevel logit model (*N* = 1642; log-likelihood = -423.1)

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	-4.91	0.53	-9.14	<.001
Prime Condition ACT	0.38	0.26	1.45	0.147
Prime Condition PASS	0.64	0.25	2.49	**0.012**
Prime Language (between)	-0.03	0.39	-0.07	0.937
Intervention (post-intervention)	1.50	0.21	6.97	<.001
L2 Proficiency	-1.01	0.42	-2.37	**0.017**
Prime Condition Active * L2 Proficiency	0.17	0.28	0.58	0.558
Prime Condition Passive * L2 Proficiency	0.70	0.29	2.36	**0.018**

Note. Final model = glmer(target response ~ Prime Condition + Prime Language + Intervention + L2 Proficiency + Prime Condition * L2 Proficiency + (1|Participant) + (1|Item), data = bilinguals, family = binomial)

The negative estimate for the intercept indicates that, in the baseline condition, the learners produced more actives than passives, and this difference was significant (*p* <.001). Following active primes, the learners did not produce more actives compared to the baseline condition (b = 0.38, 95% CI [-0.13, 0.89], *p* = .147). In fact, the positive estimate indicates that participants had the tendency to produce more passives in the active prime condition compared to the baseline condition (a similar result was also observed in Van Lieburg et al. (Chapter 2) in their cross-sectional study). This tendency is noticeable in Figure 2, especially in the between-language condition after the intervention block. Namely, the proportion for passives is about 20% in the active prime condition, while it is about 13% in the passive prime condition. We found that participants showed passive priming throughout the experiment: they produced significantly more passives after a passive prime condition than after a baseline condition (b = 0.64, 95% CI [0.14, 1.15], *p* = .012). Moreover, the positive estimate for *Intervention* indicates that participants produced significantly more passives after the intervention than before the intervention (b = 1.50, 95% CI [1.08, 1.92], *p* < .001). We believe that the effect of *Intervention* was an important contributor to passive priming. In Figure 2, it seems that passive priming only occurred in the post-intervention items in the within language condition. However, our inferential statistics suggest that passive priming occurred in all conditions, and we believe that an important part of this effect might be due to the intervention, which might have boosted the production of passives in subsequent trials, regardless of prime condition. We also found an effect of L2 proficiency in the baseline condition: all participants produced more actives than passives in the baseline condition, but the proportion of passives decreased together with proficiency (b = -1.01, 95% CI [-1.85, -0.18], *p* = .017). Though the choice for passives decreased in all conditions upon increasing L2 proficiency, we observed a significant interaction between L2 proficiency and passive priming (b = 0.69, 95% CI [0.12, 1.27], *p* = .018). Upon increasing L2 proficiency, the proportion of passive responses decreases more strongly in the baseline condition than in the passive prime condition, which created room for positive passive priming to occur in the more proficient learners (visualized in Figure 4 around a proficiency score of 57). There was no significant difference between our within-language and between-language priming condition (b = -0.03, 95% CI [-0.80, 0.74], *p* = .937).

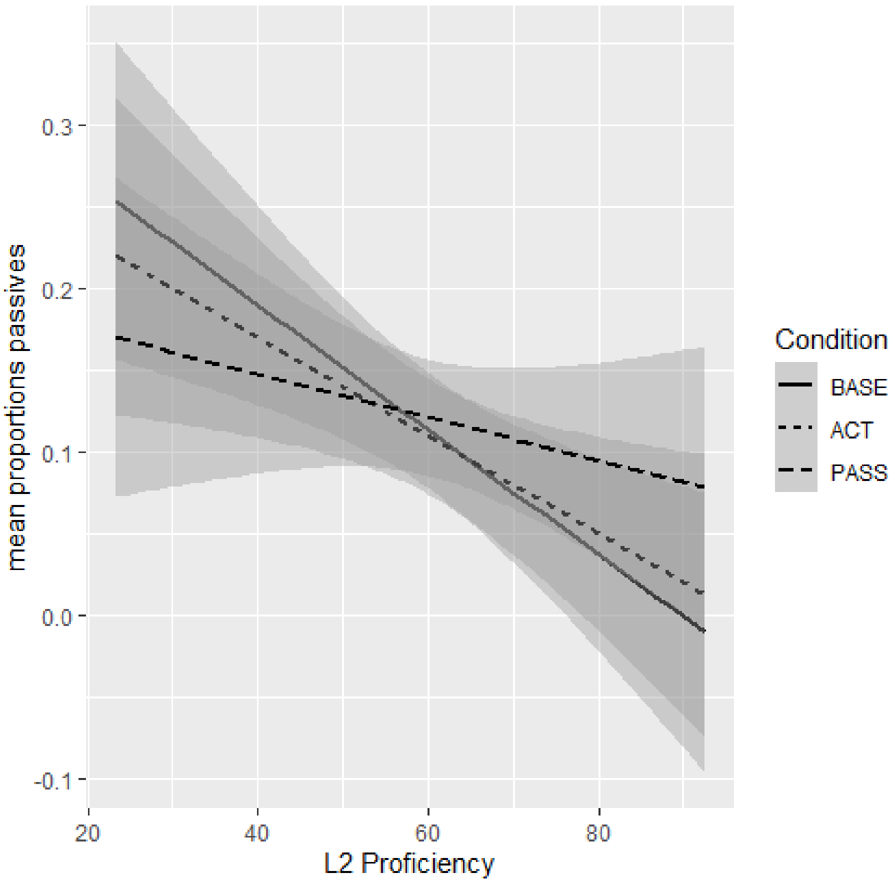

Figure 4 The interaction between passive priming and L2 proficiency. The y-axis represents the mean passive proportion, and the x-axis represents the L2 proficiency. The three separate lines represent the three prime conditions: the baseline, active, and passive condition. The significant interaction between positive passive priming and L2 proficiency is noticeable around a proficiency score of 57: as the L2 proficiency increases on the x-axis, the mean proportion of passives in the baseline condition decreases more strongly than the mean proportion of passives in the passive prime condition, which results in positive priming.

Moreover, as Figure 4 suggests, the mean proportion of passives is higher in the baseline condition than in the passive prime condition for the lower proficiency bilinguals, indicating a *negative* passive priming effect (which becomes positive as L2 proficiency increases). This suggests that, in the baseline condition, the lower proficiency bilinguals produced a higher proportion of passives compared to the higher proficiency bilinguals. Lastly, we did not find an effect of L2 proficiency on active priming (b = 0.17, 95% CI [-0.39, 0.72], p = .559).

3.3 Discussion

The results for the L2 learners show that participants produced significantly more passives after a passive prime condition than after a baseline condition. As expected, the use of passives received a significant boost from the intervention block since the bilinguals produced more passives in the post-intervention block than in the pre-intervention block. The few instances of verb overlap in the passive structure may have promoted the abstraction of the same syntactic alternant in subsequent trials without verb overlap (i.e., trials in the post-intervention block) (see Van Lieburg et al., Chapter 2, who also found the same effect due to a lexically based intervention).

Next to the effect of our passive prime condition and our intervention, we found an effect of L2 proficiency in the baseline condition: upon increasing L2 proficiency, *more* actives were produced, while the proportion of passive sentences decreased. These results are in line with our predictions in the sense that, the active syntactic structure, albeit the more frequent transitive alternant, could be regarded as the more difficult Spanish transitive variant. Therefore, it is not surprising that the higher proficiency bilinguals produced the active structure more often compared to the lower proficiency bilinguals. The less proficient bilinguals may have been hesitant to produce the active structure, and may have therefore resorted to the passive structure, which, in the case of Spanish transitives, could be regarded as the ‘easier’ variant due to its similar L1 counterpart.

We found an interaction between L2 proficiency and passive priming: higher proficiency participants produced more passives in the passive prime condition than in the baseline condition compared to lower proficiency participants. It is important to note that the proportion of passives in the passive prime condition *and* in the baseline condition decreased, while the proportion of active responses *increased* in the baseline condition, upon increasing L2 proficiency. Passive priming occurred due to two reasons: with increasing L2 proficiency, the production of actives increased in the baseline condition (while the production of passives decreased); and per unit increase in the L2 proficiency, the decrease of passives in the baseline condition was much steeper than the decrease of passives in the passive prime condition, which allowed passive priming to occur. This pattern is different from what is usually reported in structural priming studies: as one becomes more proficient, there is an *increase* in the use of passives in the baseline condition and in the passive prime condition, but this increase is much stronger in the passive prime condition than in the baseline condition, which is observed as significant passive priming upon increasing L2 proficiency (see e.g., Kim & McDonough, 2008). Thus, the direction (i.e., either positive or negative) of (passive) structural priming effects strongly depends on what happens in the baseline condition.

We did not find evidence for active priming or an effect of L2 proficiency on active priming. However, it is noticeable that participants produced many active sentences (78.1%), which were most likely not always the ‘correct active form’ (i.e., using a direct object marker when this is required). Because we wondered which predictors contributed to the production of an *incorrect* active sentence, we decided to only focus on the number of incorrect and correct active responses to our prime conditions in our next analysis (we disregarded passive sentences). We used incorrect active sentences as our reference level. This is because we assumed that participants would be more likely to produce incorrect active responses than correct active responses. We were particularly interested to investigate (1) whether incorrect actives were less often produced after an active prime condition compared to an unprimed condition; (2) whether incorrect active responses were less often produced in the within-language condition than in the between language condition; (3) whether the intervention affected the production of incorrect active forms, such that less incorrect actives were produced after the intervention block than before the intervention block and, (4) finally, whether higher proficiency Dutch-Spanish bilinguals were less likely to produce an incorrect active response compared to lower proficiency bilinguals. Investigating these questions would allow us to test whether lower proficiency bilinguals were hesitant to produce active sentences because of the risk of making a syntactic error.

4. Incorrect vs. Correct Active Responses

4.1.1. Coding

For the analysis on the active responses that were produced by the Dutch-Spanish bilinguals, we only focused on the incorrect and correct active responses for the AA-target items. We disregarded the active sentences produced for target II-items because using a direct object marker is not required for these sentences (e.g., "*El camión persigue el coche"* and "*El camión persigue al coche*" – [The truck follows the car] are both grammatically correct). Incorrect active responses were coded when participants did not use a direct object marker, when this was required (**El obrero ayuda la médica*). Correct active responses were coded if the agent of the transitive action was mentioned first followed by the verb, a direct object marker, and the patient ("*El obrero ayuda a la médica*" – The construction worker helps the doctor).

4.1.2. Analysis

Our maximal model consisted of the dependent variable *Active Response* (incorrect vs. correct, with the incorrect response as the reference level) and the predictors *Prime Condition* (baseline, active and passive, with baseline as the reference level), *Prime Language* (within vs. between, with within as the reference level), *Intervention* (pre- vs. postintervention, with pre-intervention as the reference level), and *L2 Proficiency* and their interactions. Though *Prime Language* was not a significant predictor in our previous analysis, we decided to still include this in the current analysis. This is because we hypothesized that the bilinguals (probably the higher proficiency ones) may produce less incorrect active responses in the within-language condition than in the between-language condition (see Introduction). We included random intercepts and random slopes for *Participant* and *Item* in the random effects part of our maximal model. After simplifying our maximal model, only the two-way interaction between *Intervention* and *L2 Proficiency* remained in the fixed effects parts of our final model (next to the main predictors *Prime Condition* and *Prime Language*, see Table 4). The random effects part of the final model only included *Participant* and *Item* as random intercepts.

4.2 Results

The L2 learners produced 762 active sentences the AA-target items of which 441 (57.9%) were incorrect and 321 (42.1%) were correct. Figure 5 displays the proportions of active responses (incorrect and correct) per prime condition, in the within- and between-language condition, and before and after the intervention. The most important observation from Figure 5 is that, in the within-language block, there seems to be a decrease in incorrect active responses after an active prime compared to the baseline condition in the post-intervention block compared to the pre-intervention block. In contrast, there is an increase in the same proportion (incorrect active responses after an active prime) in the between-language data.

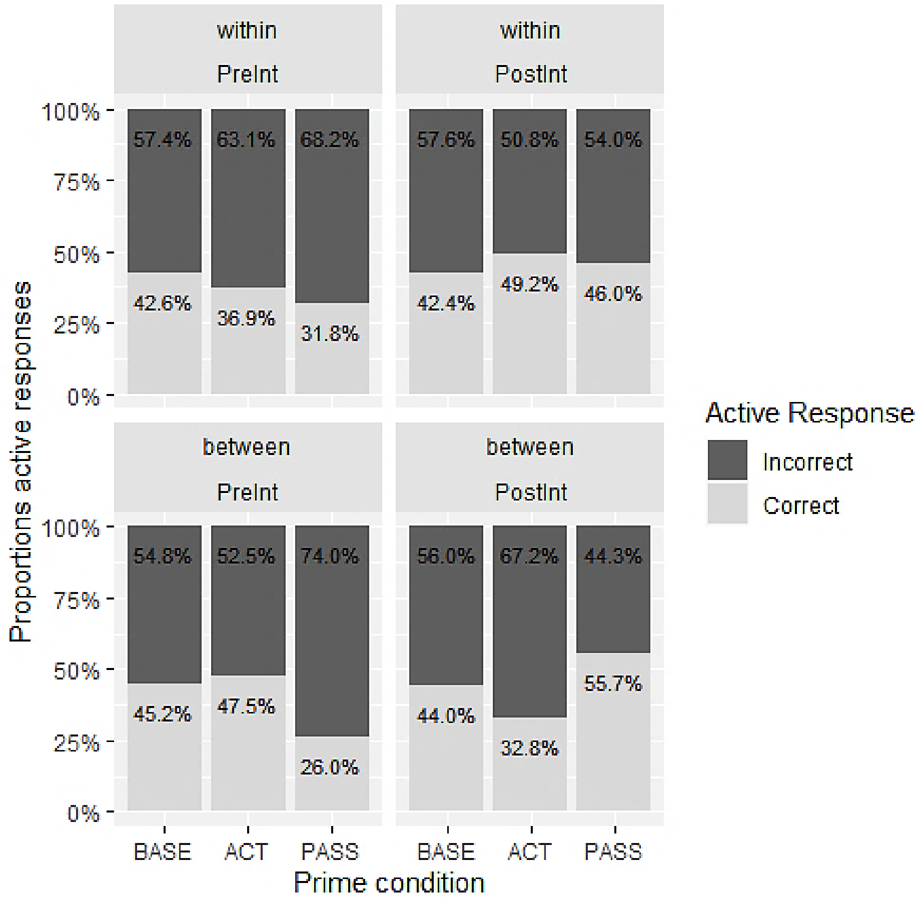

Figure 5 The proportions of incorrect and correct active responses in the within- and between-language condition for each prime condition before and after the intervention block.

The final model's intercept (see Table 4 below) corresponds to the baseline condition, the within-language condition, the pre-intervention block and a LexTALE score of zero. The intercept suggests that the bilinguals produced more incorrect active responses than correct active responses, but this difference was not significant (b = -0.72, 95% CI [-1.79, 0.33], p = .176). As illustrated in Figure 5, the proportion of incorrect active responses and the proportion of correct active responses in the baseline condition do not differ much from each other.

Table 4 Summary of the fixed effects in the multilevel logit model (*N* = 762; log-likelihood = -347.9)

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	-0.72	0.53	-1.35	0.176
Prime Condition ACT	-0.24	0.26	-0.93	0.352
Prime Condition PASS	-0.46	0.26	-1.78	0.074
Prime Language (between)	0.05	0.46	0.11	0.911
Intervention (post-intervention)	0.69	0.21	3.21	**0.001**
L2 Proficiency	-1.13	0.42	-2.66	**0.008**
Intervention: L2 Proficiency	0.46	0.21	2.23	**0.025**

Note. Final model = glmer(active response ~ Prime Condition + Prime Language + Intervention * L2 Proficiency + (1|Participant) + (1|Item), data = bilinguals, family = binomial)

We did not find an effect of the active prime condition on the proportion of incorrect active sentences (*b* = -0.24, 95% CI [-0.74, 0.27], *p* = .352); the same goes for the effect of the passive prime condition (*b* = -0.46, 95% CI [-0.97, 0.05], *p* = .074). There was no significant difference in incorrect active sentences in the between-language condition and within-language condition (*b* = 0.05, 95% CI [-0.85.95, 0.91], *p* = .911). The positive estimate for *Intervention* indicates that participants produced significantly fewer incorrect active forms in the post-intervention block compared to the pre-intervention block (*b* = 0.69, 95% CI [0.27, 1.11], *p* = .001). We also found a significant effect of L2 proficiency in the baseline condition, the within-language condition, and the pre-intervention block: the negative intercept indicates that participants produced significantly more incorrect active sentences upon increasing L2 proficiency (*b* = -1.13, 95% CI [-1.97, -0.30], *p* = .008). Figure 6 below presents the main effect of L2 proficiency on the mean proportion of incorrect active sentences. The regression line in Figure 6 indicates that the mean proportion of incorrect active forms increases, as L2 proficiency increases too.

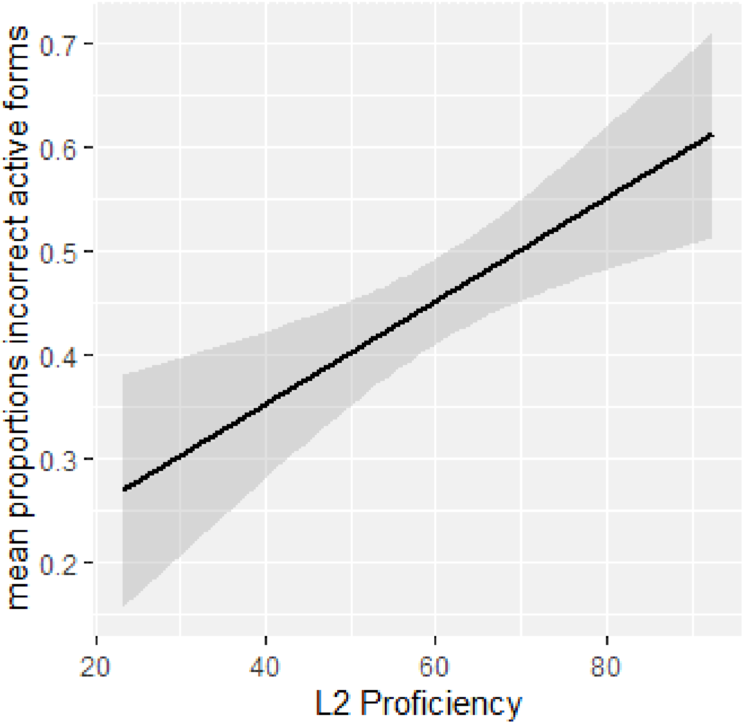

Figure 6 The effect of L2 proficiency on the mean proportion of incorrect active responses.

Lastly, there was a significant interaction between *Intervention* and *L2 Proficiency*: the positive estimate suggests that the effect of L2 proficiency on the mean proportion of incorrect active forms was significantly weaker in the post-intervention block compared to the pre-intervention block (b = -0.47, 95% CI [-0.87, -0.06], p =.024) (see Figure 7 for the interaction).

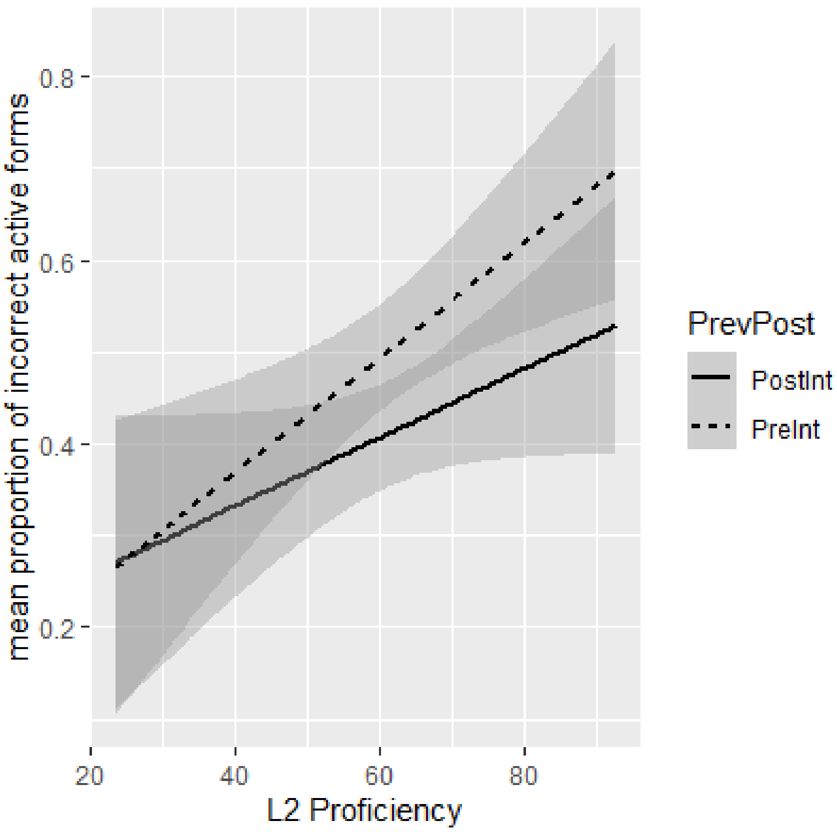

Figure 7 The significant interaction between *Intervention* and L2 Proficiency.

Finally, the effect sizes for *Condition*, *Prime Language* and the interaction between *Intervention* and *L2 Proficiency* are very small, while the effect sizes for *Intervention* and *L2 Proficiency* are small (see Chen et al., 2010). The random effects of the model explained 70% of the variance (conditional $R^2 = .70$, corresponding to a substantial effect; Cohen, 1988) and the fixed effects part explained 9% of the variance (marginal $R^2 = 0.09$, small effect; Cohen, 1988). We discuss these results below.

4.3 Discussion

The results suggest that the lexically based intervention significantly affected the production of incorrect active forms (this did not differ between the within-language and between-language condition). That is, participants produced fewer incorrect active sentences after the intervention than before the intervention. This implies that the lexical repetition in the intervention block boosted participants' correct usage of a direct object marker in active responses (in all prime conditions). Thus, a few instances of verb overlap seem to have a positive effect on the correct usage of dissimilar, but frequent, L2 syntactic alternants.

Upon increasing L2 proficiency, our results show that the learners produced more incorrect active sentences. This goes against what we expected. Namely, we hypothesized that higher proficiency bilinguals would produce fewer *incorrect* active responses than lower proficiency bilinguals. As higher proficiency bilinguals are expected to have received more L2 exposure, one would assume that they are also more aware of the morphosyntactic differences between the formulation of the active structure in Dutch and the one in Spanish. However, at the same time, this result is not entirely unexpected considering the results in 3.2, in which we found that higher proficiency bilinguals produced a higher proportion of *actives* compared to lower proficiency bilinguals. The results of 4.2 show that, although the proportion of active responses increased with L2 proficiency, these responses were mostly incorrect. This result is similar to what Bernolet et al. (2013) found for the priming of English genitives (S-genitives and Of-genitives): though higher proficiency Dutch-English bilinguals produced more S-genitives (the complex genitive alternant) than Of-genitives compared to lower proficiency bilinguals, the former bilinguals also made more syntactic errors while producing S-genitives (e.g., "**The nun her egg is yellow*" instead of "*The nun's egg is yellow*". The incorrect sentence is a syntactic transfer error from Dutch "*De non haar ei is geel*").

Lastly, the significant interaction between *Intervention* and *L2 Proficiency* indicates that the effect of L2 proficiency on incorrect active forms was weaker in the post-intervention block than in the pre-intervention block upon increasing L2 proficiency. As Figure 6 indicates, the difference in the mean proportion of incorrect active responses between the pre-intervention block and the post-intervention block becomes larger as the L2 proficiency increases. Thus, although the higher proficiency bilinguals produced more incorrect active responses throughout the experiment, they are the ones who seem to benefit the most from the intervention block. That is, because of the correct examples in the intervention, the more advanced bilinguals might have realized that they were making mistakes, which resulted in less incorrect active responses in the post-intervention items compared to the pre-intervention items.

5. General Discussion

In this study, we investigated whether a group of Dutch-Spanish bilinguals, with varying levels of Spanish proficiency, would show priming effects for two syntactic structures: a dissimilar but frequent L1-L2 alternant (actives) and a similar but infrequent L1-L2 alternant (passives). We used a cross-language priming experiment to test whether the results would align with the developmental account of L2 syntactic acquisition (Hartsuiker & Bernolet, 2017), which predicts that advanced bilinguals are more likely to show cross-language priming for complex structures (like passives) than less advanced bilinguals. However, we anticipated that passive priming would occur across all proficiency levels, both within Spanish and between Dutch and Spanish, because the passive structure is similar across the L1-L2 and may be easier to produce, especially for less advanced learners. Since we did not find an effect of our predictor *Prime Language*, this may imply that our hypothesis was confirmed: there was no difference in the within-language and between-language trials, as passive priming occurred throughout the experiment. However, we are cautious in implying that priming effects in within-and between language are equally strong, since, in our case, we believe that we did not have enough statistical power to thoroughly investigate the difference between within-language and between-language priming (e.g., Favier et al., 2019, argue that L2 proficiency modulates between-language priming, but not within-language priming. The study of Favier et al. had more statistical power [*N*=47] than our study).

An interesting finding in Experiment 2 is the effect of L2 proficiency in the baseline condition: the proportion of active responses increased upon increasing L2 proficiency, while the proportion of passive responses decreased. Though counterintuitive, these results are in line with what we expected, since the Spanish active structure may be considered to be more complex than the passive structure, such that the highly proficient bilinguals are more likely to produce this structure (though not always in a correct way) than the less proficient bilinguals. However, we also believe that there could be another reason that may explain the effect of L2 proficiency on the increase in actives. Montero-Melis & Jaeger (2019) claim that, during L2 language acquisition, L2 learner's implicit expectations might change with increasing proficiency. This means that L2 learners are expected to adapt to more native-like language expectations as their L2 input increases. In our case, since native speakers of Spanish rarely produce the passive structure spontaneously (Flett, 2003), the higher proficiency L2 learners might have implicitly adapted to the language distribution of transitives in Spanish in their own L2 syntactic production. This may have resulted in them choosing to produce more actives than passives, as this is similar to the choices a native Spanish speaker would make.

We would like to address the effect of our lexically based intervention in all three analyses. Using only a few trials, our data shows the robust effect of verb overlap. (1) Though we do not want to make any large claims in terms of the results of the native Spanish speakers, we would like to point out the trend for a significant interaction between the intervention and active priming. As the native speakers produced many active responses, we did not expect to find an effect of the intervention block on the use of actives after the intervention. However, given this trend, it could be that verb overlap between similar prime and target structures (in our case, actives) may boost the production of *frequent* alternants and not only infrequent alternants, even in native speakers who have already established a syntactic representation for these structures (Van Lieburg et al., Chapter 2, found a boost in passives after a lexically based intervention in native speakers of Dutch). (2) The data for the L2 learners show that lexical repetition in only two passive trials was enough to increase the production of passives after the intervention block. This result is similar to Van Lieburg et al. (Chapter 2), in the sense that the effect of *Intervention* in our study and Van Lieburg et al.'s study appears to be equally strong ($p < .001$) (the beta-estimate of *Intervention* in this study is 1.50, and it is 1.10 and 1.50 in Van Lieburg et al.). However, Van Lieburg et al. used four passives with verb overlap in their intervention block, while we used only two passive trials in our intervention block. These two studies imply that verb overlap, even in a minimum of two trials, increases the production of passives in subsequent trials without verb overlap in L2 learners. This may open new avenues for investigating the lexical boost effect and how it affects subsequent abstract structural priming. Usually, researchers alternate between blocks that have verb overlap and blocks that do not use verb overlap, whenever they intend on investigating the lexical boost effect (see e.g., Hartsuiker et al., 2008). We believe that one may not need to sacrifice many trials to investigate the effect of verb overlap, as it appears to be very strong, even in just a few trials. Lastly, (3) in our analysis for the incorrect vs. correct active responses, we found that a lexically based intervention may increase the correct usage of a dissimilar L2 syntactic structure that does not occur in the learner's L1. This result has not been reported elsewhere, and it might be interesting for language teachers (amongst others), who may want to employ structural priming as a training tool to teach L2 syntactic structures. It seems that verb overlap does not only accelerate the formation of abstract syntactic representations (see e.g., Van Lieburg et al.), but it also boosts the correct usage of dissimilar L2 syntactic structures.

6. Limitations and Future Direction

A first limitation of this study is that our sample size did not meet the recommendations of Mahowald et al. (2016) to reach sufficient statistical power (especially for the data of the L2 learners, in which our maximal model comprised a four-way interaction). Though Spanish is a popular language to learn, we had difficulty in finding enough participants for our study. This was probably due to the circumstances in which participants were asked to participate in our study. Since participants had to participate in their own time, and not in a controlled lab setting, many participants started the experiment, but they were not motivated to complete the task. These issues would be less likely to occur in a lab. Increasing the number of items in our experiment was not a feasible option, as the task was already cognitively demanding for participants (i.e., there were 144 items, that repetitively used the same nouns but in different sentences; this could be considered quite tedious by some).

We acknowledge that our testing method happened in an unconventional manner (i.e., participants participated remotely due to the COVID-19 pandemic). For this reason, we are not certain that participants completed the task diligently, which could have caused noise in the data compared to conventional lab-testing. Nevertheless, our study shows that structural priming is a robust method to investigate the processing of structural representations, since we still observed significant priming effects. Moreover, our testing method contributes to studies that have reported structural priming effects in non-controlled contexts (see e.g., Gries, 2005; Fricke & Kootstra, 2016; and Gries & Kootstra, 2017 for a review).

We are aware that Experiment 1 did not entirely answer our research question due to the content of the intervention block. Because passives are even less preferred by native speakers of Spanish during spoken dialogue, than by, for instance, native speakers of Dutch, the intervention block should have only consisted of passive sentences. By doing this, it would have provided us with accurate insights as to whether the increase in passives after the intervention was solely due to the lexically based manipulation. If future studies were to replicate our study, we strongly urge them to use only passives in the intervention block in the experiment for native speakers of Spanish.

In Experiment 2, we did not find active priming. Based on Hartsuiker and Bernolet's (2017) developmental account for L2 syntactic acquisition, we predicted that, though the Spanish active structure is more frequent than the passive structure, it is also dissimilar from its Dutch counterpart due to its morphosyntactic realization; and this may impede late Dutch-Spanish bilinguals from showing active priming. However, one may wonder whether we did not find active priming because of the dissimilarity between the active structure in Spanish and Dutch or, as proposed by the implicit learning account (Chang et al., 2006), whether this is due to the relative frequency of the active structure. Based on the predictions of the implicit learning account, it is not surprising that we only found passive priming and no active priming in the learners, as less frequent structures (passives) induce larger priming effects than more frequent structures (actives). Thus, in our study, it is difficult to tease apart whether the absence of active priming could be due to the dissimilarity between the active structure in the L1 and the L2 or due to relative frequency effects. Similarly, it is also hard to determine whether passive priming could be attributed to its L1-L2 similarity, or whether the inverse frequency effect might have played a bigger role in structural priming to occur.

The aforementioned brings us to a more general limitation of this study. Namely that our predictions were solely based on the developmental account of L2 syntactic acquisition (Hartsuiker & Bernolet, 2017), which is rooted in the residual activation theory (Pickering & Branigan, 1998). The residual activation theory predicts short-term structural priming effects, but it is very likely that the absence of active priming and the presence of passive priming reflect a long-term learning process instead. If future studies were to solely base their predictions on the developmental account of L2 syntactic acquisition, we propose that they use syntactic alternants of which the relative frequencies do not differ much from each other and of which one of the alternants is unambiguously dissimilar (e.g., uses a completely different word order) in the L2 compared to its L1 counterpart. For instance, future studies could consider priming the Spanish active OVS structure (see Introduction) vs. the passive structure in L2 learners of Spanish with L1 Dutch, as the Spanish active OVS structure is less frequent than the active SVO structure and has a dissimilar word order compared to the active structure in Dutch.

7. Conclusion

In this study, we found passive priming, but no active priming, in late learners of Spanish learners with L1 Dutch. Though our results imply that passive priming may have occurred due to the similarity of this structure between Dutch and Spanish, we also believe that this cannot only be explained by the predictions rooted in the residual activation theory. In an ideal situation, cross-language priming studies should incorporate aspects of the residual activation theory and the implicit learning account (see Reitter et al., 2011 for a monolingual hybrid model of structural priming) to better answer how bilinguals develop and establish syntactic representation of similar and dissimilar L2 syntactic structures in the L2 and between the L1-L2. Interestingly, our study shows that L2 proficiency is an important predictor for the production of dissimilar L2 syntactic structures: more advanced bilinguals were more likely to produce the morphosyntactically dissimilar Spanish active structure than the less advanced bilinguals. Lastly, using a lexically based intervention block, we showed that a few trials with verb overlap do not only boost the production of passives in subsequent trials without verb overlap, but that such an intervention also boosts the correct usage of L2 dissimilar structures.

CHAPTER 4

L2 PROFICIENCY MODULATES STRUCTURAL PRIMING EFFECTS OF DISSIMILAR L2 SYNTACTIC STRUCTURES

All data, analysis code, and experimental lists are available at

https://osf.io/ehz8n/?view_only=bd09af15be7b4b929ba14fa07ad32432

Abstract

We investigated abstract structural priming of Dutch (PP-final and PP-medial) passives in a within-Dutch structural priming experiment in French-Dutch bilinguals. In contrast to Dutch, French only allows the PP-final passive. We asked whether late L2 learners can be primed to produce structures that are dissimilar from L1 syntactic alternants (i.e., the PP-medial passive) and whether this depends on L2 proficiency. We observed an unexpected production preference for the PP-medial. There was priming for both PP-final and PP-medial passives. We discovered that the learners had been explicitly taught to use the PP-medial passive structure. This, together with L2 proficiency, affected the production biases and structural priming effects: lower L2 proficiency speakers mostly produced PP-medial passives and showed strong PP-final priming, whereas higher proficiency L2 speakers produced PP-medial and PP-final passives, creating room for PP-medial priming. We conclude that L2 proficiency is an important factor for the priming of both similar and dissimilar L2 syntactic structures

Keywords: structural priming, L2 syntax acquisition, L2 Proficiency, sentence production

1. Introduction

An important component of second language (L2) production is to generate grammatically correct sentences. However, if an L2 is learned in adulthood, this often comes with challenges. Because late L2 learners have already fully acquired their first language (L1) lexical-and-syntactic network, L1 syntactic knowledge might be helpful in the formulation of L2 syntactic structures, especially when L1 and L2 syntactic structures can be directly mapped onto each other (Hartsuiker & Bernolet, 2017). However, L1 syntactic knowledge might also hamper L2 syntactic production. For example, a late learner of English with L1 Dutch might say the following in English: **Have you 20 boys and girls invited?* which contains a word order error from the L1 "*Heb je 20 jongens en meisjes uitgenodigd?*" (correct: *Have you invited 20 boys and girls?*). One way to avoid L2 syntactic errors is to keep L2 syntactic information separated from L1 syntactic information. In this case, the learner learns all new L2 syntactic structures. However, if late L2 learners learn all L2 syntactic structures, they might also learn syntactic alternants of which one variant is similar to a structure in their L1 and another that is dissimilar to its L1 counterpart and that does not exist in the L1. For instance, Spanish allows an OVS word order next to an SVO word order, whereas English allows only the latter. When an English native speaker with L2 Spanish wishes to produce an active sentence, they[1] may either use an active sentence with an SVO word-order (e.g., *El autobús persigue la bicicleta – The bus chases the bike*) or an active sentence with an OVS word-order (e.g., *La bicicleta lo persigue un autobús* - **The bike* [chasee] *it chases a bus* [chaser]). In this situation, one might wonder which one of the two word order variants late L2 learners of Spanish choose to produce, the similar SVO word order or the dissimilar OVS word order?

[1] Throughout this article, we will use the gender neutral *they* to refer to a previously mentioned singular subject.

In this paper, we ask whether L2 learners can be primed to produce *dissimilar* L2 syntactic structures in their second language if there is also a syntactic structure available that is similar between the L1 and L2. We test this question with *structural priming*. Structural priming is the phenomenon by which the processing of syntactic structures is facilitated by previously encountering the same syntactic structure (Bock, 1986). For example, speakers will be more likely to produce a passive sentence (*The dog was bitten by the cat*) upon hearing a passive sentence (*The man is being followed by the car*) than when they have just heard its active counterpart (*The car follows the man*). Structural priming is usually investigated in comprehension-production tasks where participants alternate between reading or listening to prime sentences and describing or completing target sentences. Many studies have shown that structural priming is a robust method to investigate the syntactic structures that speakers access during syntactic processing; and this has been investigated in different structures, modalities, and populations (see Mahowald et al., 2016 for a meta-analysis). Structural priming is a suitable method to investigate our research question because we ask whether there is a syntactic representation for dissimilar L2 structures, which may not be produced spontaneously due to the presence of a similar L2 syntactic alternant. Our question is relevant because if priming of dissimilar L2 structures is possible, this suggests that L2 learners may develop a representation for similar *and* dissimilar L2 structures.

Previous studies have also proposed that an increasing L2 proficiency plays an important role in the establishment and use of L2 syntactic structures that are similar across languages (S-genitives in English and Dutch, e.g., *Noa's shoes – Noa's schoenen*, see Bernolet et al., 2013). We predict that L2 proficiency is also crucial in the establishment and production of dissimilar L2 structures across languages, specifically if there is an alternative available that is similar between languages and that may be learned faster. We assume that dissimilar L2 syntactic structures will be produced only if a high enough L2 proficiency has been reached.

Structural Priming in Bilinguals

Work on structural priming in bilingual speakers follows from the assumption that if a bilingual produces a syntactic structure in one language, this affects the production of a syntactic structure in their other language, *whenever the structures in question are similar enough* (Hartsuiker & Bernolet, 2017). For instance, Hartsuiker et al. (2004) found that Spanish-English bilinguals were more likely to produce English passives after they had heard a Spanish passive prime sentence (e.g., prime: *El camión es perseguido por el taxi* [*The truck is chased by the taxi*] – target: *A bottle is hit by a bullet*), than when they had heard Spanish actives (*El taxi persigue el camion*). Based on this, Hartsuiker et al. proposed a lexical-syntactic bilingual model for language production, which is rooted in the residual activation theory (Pickering & Branigan, 1998). The residual activation theory emphasizes the role of lexical representations during the selection of syntactic structures. When one uses a passive sentence, there is short-term activation of the lexical representation of the transitive verb (e.g., *to chase*) and the syntactic representation for the passive. Importantly, the link between the lexical representation and the syntactic representation is strengthened when both representations are activated. The residual activation that results from this incites speakers to re-use the same syntactic structure for the formulation of a new transitive sentence, even if they encounter a different transitive verb (e.g., *to hit*). In the case of bilinguals, activation of lexical items in one language leads to activation of translation equivalents and activation of shared syntactic representations in the other language (Hartsuiker et al.). Because of this integrated view, where lexical and syntactic information are shared as much as possible, cross-linguistic structural priming (i.e., the influence of recent exposure to a syntactic structure in one language on syntactic processing in another language, see Kootstra & Muysken, 2017) occurs for similar structures between two languages.

Bernolet et al. (2013) proposed that L2 proficiency plays an important role in the sharing of syntactic representations in the sense that L2 representations evolve gradually from item- and language-specific representations to abstract representations that are shared across languages as L2 proficiency increases. Consequently, Bernolet et al. suggest that the lexical-syntactic bilingual model of Hartsuiker et al. (2004) represents the last stage of L2 syntax acquisition, where L2 learners are proficient enough to share similar syntactic structures between languages. In their developmental account for L2 syntax acquisition, Hartsuiker and Bernolet (2017) propose that L2 syntax acquisition occurs in a sequence of phases where L2 proficiency plays a crucial role in the sharing of syntactic representations between languages. That is, initially, L2 learners only have lexical representations without syntactic information connected to them and they either imitate native speakers or use their L1 syntactic knowledge to formulate a sentence in their L2. As L2 proficiency increases, L2 lexical and syntactic representations are abstracted and merged with the L1, if the structures are similar enough. Note that the developmental account also proposes that L2 abstract representations are formed earlier for more frequent structures (e.g., actives) than for less frequent ones (e.g., passives). Cross-linguistic priming can be observed in the last phase of the abstraction process; priming for complex structures in the L2 is assumed to occur in within-language priming before it occurs on the basis of L1 primes (see e.g., Hwang et al., 2018). Importantly, the developmental account of L2 syntax acquisition does not explain which (learning) mechanisms may be responsible for structural priming. A phenomenon that is not accounted for by the developmental theory is that low frequent structures (e.g., passives) elicit stronger priming than high frequent syntactic alternants (e.g., actives), the so-called *inverse frequency* *effect* to structural priming (Chang et al., 2006), which has been observed in several studies investigating structural priming in the L1 (see e.g., Segaert et al., 2016).

The L2 syntax acquisition account also proposes that syntactic structures need to be *similar enough* for sharing to occur between languages. However, it is not clear whether L2 speakers learn and eventually share L2 structures that are different (e.g., due to word order differences) from their L1 counterpart, when the L2 also has an alternative structure that is similar to the L1. A shared syntactic structure means that there is one syntactic representation, for instance, for passives, which is connected to all transitive verbs in a bilingual's mental lexicon. Van Gompel and Arai (2018) propose that structures that differ in word order between languages are *connected* rather than fully shared. If this were true, this implies that similar structures would show stronger priming than dissimilar structures between languages. However, Bernolet et al. (2009) suggest that, in the case of transitives, even if syntactic structures are dissimilar, cross-linguistic priming can still occur based on information structure (see also Chen et al., 2013, who suggest that word-order similarity between language is not necessary for priming to occur). In a between-language priming experiment with Dutch-English bilinguals, Bernolet et al. found priming between two passive forms that differ in the order of the past participle and the prepositional phrase, namely Dutch PP-medial passives (*De hond wordt door de kat achtervolgd* – [**The dog is by the cat being followed])* and English PP-final passives (*De hond wordt achtervolgd door de kat* - [*The dog is being followed by the cat]).* Note that the priming direction of the between-language priming experiment was from Dutch, that allows the PP-final and PP-medial passive, to English, that allows only the PP-final passive. The learners were not primed to produce a new L2 syntactic structure that does not occur in their L1. What would happen in such a case?

Recent work from Muylle et al. (2021b) suggests that, in such a case, the learning of the structure that is similar between the L1 and the L2 might block the learning, and eventually the sharing, of the dissimilar L2 structure with its L1 counterpart. Muylle and colleagues refer to this as the *blocking effect* (derived from Kamin's blocking effect, 1969, but see also Ellis, 2006): because the association between similar structures is made first, it is more difficult to learn the association between dissimilar ones. Muylle et al. tested this in native speakers of Dutch who learned an artificial language (AL) that allows an SVO and SOV word order in transitives and ditransitive sentences in the main clause. In contrast, Dutch allows an SVO word order in the main clause (e.g., *Hij eet een appel – He is eating an apple*), while an SOV worder is not allowed in the main clause (**Hij een appel eet* – **He an apple eats*)[2]. Muylle et al. found stronger priming for SVO structures compared to SOV structures *within* the artificial language, which suggests that blocking effects were already present in the establishment of structural representations in the AL. Muylle and her colleagues propose that because the Dutch SVO structure is similar to the SVO structure in the AL, participants were faster in forming representations for the SVO structure in the artificial language and this blocked the formation of the dissimilar SOV representation. However, the researchers still found weak priming for the SOV in the artificial language. Because of this, Muylle et al. claim that the blocking effect does not imply that there is no learning of dissimilar L2 syntactic structures, but that this learning is impeded due to the presence of a similar L2 alternative.

While an artificial language has several advantages (e.g., full control of language exposure), its biggest drawback is that it does not translate to an ecologically valid learning situation, since speakers often only use the language in a lab. For this reason, we investigate our research question in a natural L2 learning situation.

[2] Except for questions, for instance, *eet hij een appel*? - **eat him an apple*? and for sentences where an adverbial is mentioned first in the main clause (e.g., *in de ochtend eet hij een appel* – **in the morning, eat him an apple*). Both constructions apply a VSO word order.

The Current Study

We investigate our research question in two forms of the Dutch passive: the PP-final passive (the most frequent alternative) (*De hond wordt achtervolgd door de kat – The dog is being followed by the cat*) and the PP-medial passive (the less frequent alternative) (*De hond wordt door de kat achtervolgd- *The dog is by the cat being followed*). We conducted a within-Dutch structural priming experiment with native Dutch speakers and late learners of Dutch with L1 French. French only allows the PP-final passive, which is similar to the Dutch PP-final passive (*Le chien est poursuivi par le chat*), while it does not allow a PP-medial passive (**Le chien est par le chat poursuivi*). Investigating the native speakers' priming pattern for both passive forms would allow us to compare their results to the group of French-Dutch bilinguals (whom we tested in Wallonia and Brussels, Belgium). Also, no other study has investigated priming *within* the passive voice in native Dutch speakers (in our study, actives were considered 'other' responses in the experimental block, see *Coding* below); thus, it was important to investigate the priming pattern of these speakers too.

We assume that most L2 learners will have a PP-final passive representation, because they can retrieve syntactic information from the passive in French and copy-and-edit that for the production of the Dutch PP-final passive. In terms of the PP-medial passive, we hypothesize that the L2 learners may learn this structure spontaneously, granted that they are sufficiently exposed to Dutch. The late learners might have developed a representation for the PP-medial passive, due to, for example, exposure from L2 reading. However, unlike native speakers, the late learners may also learn the PP-medial passive through explicit instruction. This may affect the extent to which the PP-medial passive is learned and produced. In any case, we hypothesize that the learning of the L2 PP-medial passive might be impeded, as the L2 PP-final passive structure is learned faster and may be already shared with the L1 PP-final passive representation (in line with the blocking effect). Consequently, we expect to find a

PP-final passive production bias in our baseline condition, and it is more likely that we will observe PP-final priming than PP-medial priming.

We only investigate within-Dutch structural priming in unrelated conditions (i.e., no verb overlap between prime and target) because we were interested in the extent to which the L2 learners could be primed to produce the PP-medial passive, which may not be produced spontaneously because there is already a similar alternative (PP-final passive) available. If we find PP-medial priming, in the absence of verb overlap, this means that the L2 learners have an abstract syntactic representation for the PP-medial passive and that they can use this representation for L2 sentence production. We were only interested in the production of the two Dutch passive forms, and thus we elicited passive sentences by framing the patient with a red line in our materials for the experimental block. Therefore, we told participants to always start their sentence production with the person or object that was framed in red (see Segaert et al., 2016)

LexTALE as a measure of L2 Dutch proficiency

To investigate the role of L2 proficiency during L2 syntax production, we used the online Dutch version of the LexTALE (Lemhöfer & Broersma, 2012) to measure the L2 learners' Dutch proficiency. The LexTALE is an unspeeded lexical decision task that lasts approximately 5 minutes and contains 60 items. During the task, participants read words on their screen, one by one, and must indicate whether the word exists (40 items) or does not exist (20 items). The 60 items were chosen based on a pilot study amongst 18 Dutch participants who had to make a word/nonword decision on a dataset of 240 items. Following this, the 60 items with the highest item-total correlations (i.e., how well an item discriminates between the item score and the overall assessment score) were selected for the vocabulary test.

Lemhöfer and Broersma (2012) validated and tested the LexTALE for English as a second language. They recruited 72 Dutch and 87 Korean learners of English. For these learners, they observed strong correlations between the scores of the LexTALE and different translation tests (*r* between 0.66 – 0.78 for the Dutch participants, and 0.46 – 0.51 for Korean participants). The researchers reported that the LexTALE is a good indicator of general English proficiency, since the scores on the LexTALE correlated with the Quick Placement Test (QPT, 2001), especially for the Dutch participants (*r* = 0.63). Furthermore, Lemhöfer and Broersma assessed participants' self-ratings on writing, reading, listening, and speaking proficiency. Though self-ratings were significant predictors of the translation tests and general proficiency variables, obtained from the scores on the QPT, the scores on the LexTALE turned out to be more reliable predictors than the self-ratings. We chose to use the Dutch version of the LexTALE to measure proficiency in L2 Dutch, (1) because the Dutch version was developed and designed parallel to the English variant. (2) Furthermore, because our experimental task lasted quite long (50 – 60 minutes, see *Procedure*), it was more feasible to include the LexTALE as an indication of L2 proficiency than an extensive self-rated proficiency questionnaire. Many other studies have used the LexTALE as an indication of L2 proficiency (see e.g., Singh & Mishra, 2015). The test is available online (www.lextale.com); the scoring and item list can also be found on the website.

For the present study, we assume that L2 proficiency is an important factor for L2 syntactic production. We expect highly proficient L2 learners to show priming for the PP-final and PP-medial passive during L2 production. For lower proficiency L2 speakers, we expect priming for the similar alternative (PP-final passive) but no priming yet for the dissimilar alternative (PP-medial passive).

To summarize, the goal of this study is to test whether late learners of Dutch with L1 French can be primed to produce the dissimilar PP-medial passive or only the similar alternant between Dutch and French, the PP-final passive. We assume that there is already a representation for the PP-final passive and that the L2 learners will show a production preference for this structure in the baseline condition. We predict that the learners will show priming for the similar PP-final passive and no priming for the dissimilar PP-medial passive, analogous to the blocking effect. We also hypothesize that L2 proficiency may affect the extent to which the PP-medial passive is produced: higher L2 proficiency speakers may show stronger priming for this structure than lower L2 proficiency speakers. We tested our predictions in a within-Dutch structural priming experiment.

2. Method

2.1. Participants

We recruited two groups of participants. The first group consisted of 48 native Dutch speakers (41 females and 6 males, one participant did not provide their gender and age) and they had a mean age of 22 years, *SD* = 2.43, 95% CI [21.28, 22.71], range = 17-32. We determined our sample size based on the recommendations by Mahowald et al. (2016) (see Appendix S1 for an elaboration on this).

Additionally, we recruited 96 French-Dutch bilinguals (71 females and 25 males) with a mean age of 21.49 years, *SD* = 2.52, 95% CI [21.97, 22.00], range = 18-29. This group was larger than the native speakers because we were interested in an interaction between L2 proficiency and our prime conditions (an interaction requires more statistical power, Mahowald et al., 2016). The learners were sequential bilinguals and they had acquired Dutch outside a home context (i.e., in kindergarten[3], Dutch immersion school, Dutch courses etc., [see Appendix S1 for additional information on the learners' background]).

[3] Thirty learners indicated that they had started learning Dutch from an early age (i.e., before primary school, thus between 2 – 5 years). Some participants (4 out of the 30 learners) indicated that they attended kindergarten in a Dutch immersion context, which explains their early L2 acquisition. Though the remaining learners (from the 30 learners) indicated that they had learned Dutch at school, they did not specify what could have led to their early L2 acquisition.

Participants filled out a language questionnaire (a short version of the LEAP-Q, *Language Experience and Proficiency Questionnaire*, adapted from Marian et al., 2007). The most important information from the LEAP-Q and the LexTALE scores is presented in Table 1. The self-rated Dutch proficiency scores were based on a 7-point Likert scale ranging from very bad to very good. The self-rated proficiency and the LexTALE scores of the L2 learners were moderately correlated (production: $r(94) = .56$, $p < .001$; comprehension: $r(94) = .57$, $p < .001$). All participants provided written consent for their participation and received a gift voucher in exchange for their participation.

Table 1 Profile of the Two Groups

	M *(SD)*	95% CI [,]	Range
Native Dutch speakers (N=48)			
Age of Dutch education	4.75 (1.41)	[4.30, 5.20]	3.0 – 7.0
LexTALE score	88.96 (8.06)	[86.61, 91.30]	56.25 – 98.75
L2 learners (N=96)			
Age of Dutch acquisition	7.67 (4.16)	[6.83, 8.51]	1.0 – 24.0
Age of Dutch education	7.96 (4.12)	[7.13, 8.80]	2.0 – 24.0
LexTALE score	67.32 (9.96)	[65.30, 69.33]	47.50 – 93.75
Self-rated Dutch proficiency: production	4.38 (1.32)	[4.11, 4.65]	2.0 – 7.0
Self-rated Dutch proficiency: comprehension	5.17 (1.30)	[4.90, 5.43]	2.0 – 7.0

Note. The native Dutch speakers all indicated a score of 7 on their self-rated Dutch proficiency in production and comprehension

2.2. Materials and Design

Our materials comprised black-and-white line drawings adapted from Bernolet et al. (2009) and included pictures from the International Picture Naming Project (Bates et al., 2003) depicting either transitive events (e.g., *to follow, the nun follows the king*), intransitive events (e.g., *to cry, the nun is crying*) or conjoined noun phrases (e.g., *the nun and the king*). The Dutch verb describing the (in)transitive event was displayed at the bottom the pictures. In pictures depicting transitive events, we counterbalanced the position of the patient (left or right side of the target picture). In this way, passive sentence production could not be related to the position of the patient on the picture.

Pre-experimental Block

We used a pre-experimental block to assess participants' spontaneous sentence production preferences for transitives in the absence of priming. This block consisted of a description set with 24 pictures: 12 pictures displayed transitive events and the other half displayed intransitive events.

Experimental Block

We used an experimental block to investigate the priming of PP-final and PP-medial passives. The experimental block consisted of 108 sentences, a verification picture set, and a target picture description set. There were 36 experimental prime sentences, which were divided into three conditions: 12 primes were PP-final passives (*e.g., De hond wordt achtervolgd door de kat*), 12 primes were PP-medial passives (*e.g., De hond wordt door de kat achtervolgd [The dog is being followed by the cat]*), and 12 items were baseline items, consisting of conjoined noun phrases (*de hond en de kat [the dog and the cat]*) (see Bernolet et al., 2009). Employing a baseline condition allowed us to determine whether only one of the primes affected the syntactic choices and structural priming effects relative to the baseline. The remaining 72 sentences were fillers: 48 could be described with intransitive verbs and the other 24 with transitive verbs in the *active voice*. We included active sentences as fillers in the hope that this would further mask the occurrence of passive sentences in the critical prime sentences. All 108 sentences were recorded into separate audio files. The Dutch native speakers and the L2 learners performed the same experiment, but the sentences were recorded by a native Dutch speaker for the former group and a French-Dutch bilingual for the latter one. We chose to use a French-Dutch bilingual because a native Dutch speaker would probably pronounce words “too nativelike”, which deviates from how the learners pronounce Dutch words themselves. We do not believe that using two different speakers would affect each group’s performance since we tested response tendencies (either the production of PP-final or PP-medial passives) and not, for instance, response latencies.

The 108 pictures for the verification set were used for the distractor task. Sixty verification pictures showed transitive verb events and 48 intransitive verb events. Half of all the verification pictures matched the prime sentences and the other half did not match the prime sentences.

Additionally, we selected 108 pictures for the target description set. Thirty-six pictures were experimental target pictures, that could be described with transitive verbs. There were also 72 filler items. Twelve of these fillers used conjoined noun phrases. We added these pictures to the set so that participants would not only hear conjoined noun phrases in the baseline items but would also produce them in the target pictures. Twenty-four of the filler items were actions with intransitive verbs. The remaining 36 fillers elicited the production of the *active voice* by framing the agent in a red square. Crucially, whereas participants could describe the pictures in the pre-experimental block spontaneously, we elicited passive sentences for the critical trials and active sentences for the filler trials, in the experimental block, by using a red-colored frame. By doing this, we diminished active sentence production as much as possible, which allowed us to investigate the passive sentence distribution in the critical targets.

Finally, the prime-target pairs were pseudorandomly mixed with the filler items, with the constraint that the first four items in the experimental block were fillers. Each prime and target pair was followed by either one, two, or three filler items. We created six lists based on our three prime conditions (PP-final passive, PP-medial passive, and BASE) and our control for patient position within each experimental item (either left or right). We randomly assigned 8 participants from the control group and 16 participants from the experimental group to each list. The experiment was programmed in *PsychoPy* v.3.2.4 (Peirce et al., 2019).

2.3. Procedure

Participants were tested in a quiet room in front of a laptop and were provided with headphones. Participants were told they would be playing a dialogue game, where they would be verifying and describing pictures. The description of a target picture had to start with the person or object that was framed with a red color. Participants started with the pre-experimental block in which they had to describe the pictures spontaneously. After the pre-experimental block, participants could start with the experimental block.

During the experimental block, participants first heard a prime sentence, which was accompanied with a picture of an *ear* that prepared participants to focus on listening. At the end of the prime sentence, participants pressed the spacebar. Consequently, a verification picture appeared on the screen and participants either pressed [1] if the picture matched the description they had just heard or [2] if the description did not match the description. The verification task was unambiguous: the verification picture had no single overlap with the prime sentence such that it was clear that participants had to press [2] for a ‘no-match response'. Subsequently, a target description picture appeared on the screen, and participants started their production with the person or object that was framed in red. To remind participants of the target production trials, we added a *speaking symbol* to the left of the target picture. Participants performed the Dutch LexTALE language test (Lemhöfer & Broersma, 2012), which was followed by the LEAP-Q, at the end of the experiment. Sessions for the native speakers lasted 30 minutes, but the L2 learners took approximately 50-60 minutes for the experiment. Afterwards, participants were debriefed about the goal of the study.

2.4 Coding of responses

The responses were manually coded as active sentences, PP-final passives, PP-medial passives, or "Other" responses. Importantly, active sentences were coded as correct responses only in the pre-experimental block. Since we were interested in passive responses in the experimental block, active sentences were coded as incorrect responses during this block. A response was coded as an active structure if the agent of the transitive event was mentioned first followed by the verb and the patient. PP-final passive responses were coded when the patient was mentioned first and if the sentence ended with a prepositional by-phrase using the preposition *door* (*by*). PP-medial passives were coded when the patient was mentioned first, and the prepositional by-phrase occurred in the sentence medial position and if the sentence ended with the past participle. "Short passives", in which the agent is not overtly realized (e.g., *de bokser wordt achtervolgd* [*the boxer is being followed*]), were coded as "Other" responses. Moreover, responses such as *De bokser wordt/is achtervolgd* ***bij*** *de piraat* - **The boxer is being followed at the pirate* were also categorized as "Other" (because the overt passive marker *door* (by) was not produced).

<u>*2.5 Analysis*</u>

First, we conducted a joint analysis for the pre-experimental block, that included Dutch native speakers and the French-Dutch bilinguals, in which we investigated participants' spontaneous sentence production in the absence of priming. Towards this aim, we only included participants who met our criteria[4]. Second, we performed a joint analysis for the experimental block, that included both groups, to investigate how the L2 learners differed from the native speakers with regards to the priming effects. For this, we tested for an interaction between *Prime Condition* and *Group* (with BASE and Dutch native speakers as the respective reference levels). Third, based on our hypothesis, we conducted a separate analysis on the L2 learners' data to investigate how the priming effects for both passive alternatives interacted with Dutch proficiency (obtained from the raw scores on the LexTALE test – these were scaled and centered). We also performed a separate analysis on the native speakers' data but for the sake of brevity and because our study focuses on the learners and the difference between the two groups, the analysis of the native speakers can be found in Appendix S2.

In all our analyses, we fit generalized linear mixed-effects models, of which the *beta* estimates are log odds ratios, as implemented in the *lme4* package (Bates et al., 2015). We report the *beta* estimates and the R squared values of the final model (as estimated by the *report* package), as these are measures of effect size. The dependent variable (PP-final passive vs. PP-medial passive, with PP-final as reference level) was binary. Following the random effect structure as proposed by Barr et al. (2013), we added random intercepts and random slopes for *participant* and *item*. We used an alpha level of .05 for interpreting statistical significance.

[4] Our criteria were that the L1 of the native speakers could only be Dutch; the learners were not allowed to have multiple L1s (only French), and they had to be sequential learners of Dutch. Lastly, all participants had to be between 18-30 years old.

Our maximal models were simplified in a stepwise way (as recommended by Fitzmaurice et al., 2001) due to convergence and singularity issues. We simplified the random effects structure by successively testing if the random slope terms could be omitted without decreasing the fit of the model. Significance of the random slopes was tested using likelihood ratio tests. We removed random slopes for *items* before removing any random slopes for *participants* because the variance for *items* is usually smaller than for *participants* (see Segaert et al., 2016). The final random effects structure in all our analyses included only random intercepts by *participant* and by *item*. Lastly, we checked for violations of the distribution of residuals or of homogeneity of variance for each final model, as implemented by the *DHARMa* package (Hartig, 2021), and we looked for influential participants using the *influence.ME* package (Nieuwenhuis et al., 2012) by investigating whether there were participants with a high Cook's distance[5]. If we found violations of assumptions or identified influential participants, we report whether these findings affected the interpretations of our results.

3. Results

Joint analysis

<u>*Pre-experimental block*</u>

Based on our criteria, four native Dutch speakers were excluded from the total of 48 participants. Two participants reported that Dutch was not their only L1; two other participants did not meet the age criteria. Four participants from the 96 L2 learners were excluded because they had indicated that French was not their only L1. Consequently, the total group consisted of 136 (44 + 92) participants. In the pre-experimental block, the native

[5] Cook's Distance measures the relative influence of each participant in the data on the results of a regression model (Cook, 2011). It is used to investigate whether one or more participants have a large effect such that it changes the overall results of the regression output.

speakers produced 528 responses. Of these responses, 112 were "Other" responses (21.2%), 376 active responses (71.2%); and 40 PP-final passives (7.6%). The L2 learners produced a total of 1,101 responses. There were 320 "Other" responses (29.1%), 735 active responses (66.8%), 20 PP-final passives (1.8%); and 26 PP-medial passives (2.4%). Note that we deleted the number of "Other" responses in Figure 1. Due to the small number of passive responses, no statistical models were fit on the pre-experimental block data. At the individual level, 28 native speakers only produced active responses and 15 native speakers produced actives and PP-final passives[6]. Moreover, 68 L2 learners only produced actives responses, 3 learners produced actives and both passive forms; 11 learners produced actives and PP-final passives, and 9 produced actives and PP-medial passives[7]. Unlike the native speakers, the L2 learners produced both PP-medial and PP-final passive responses.

[6] There was one native speaker who only produced "Other" responses in the pre-experimental block.
[7] Learners who produced actives and PP-final passives had an average LexTALE score of 67.32. Learners who produced actives and PP-medial passives had an average LexTALE score of 70.79. Note that these values do not differ (much) from the average score of all participants 67.32 (see Participants).

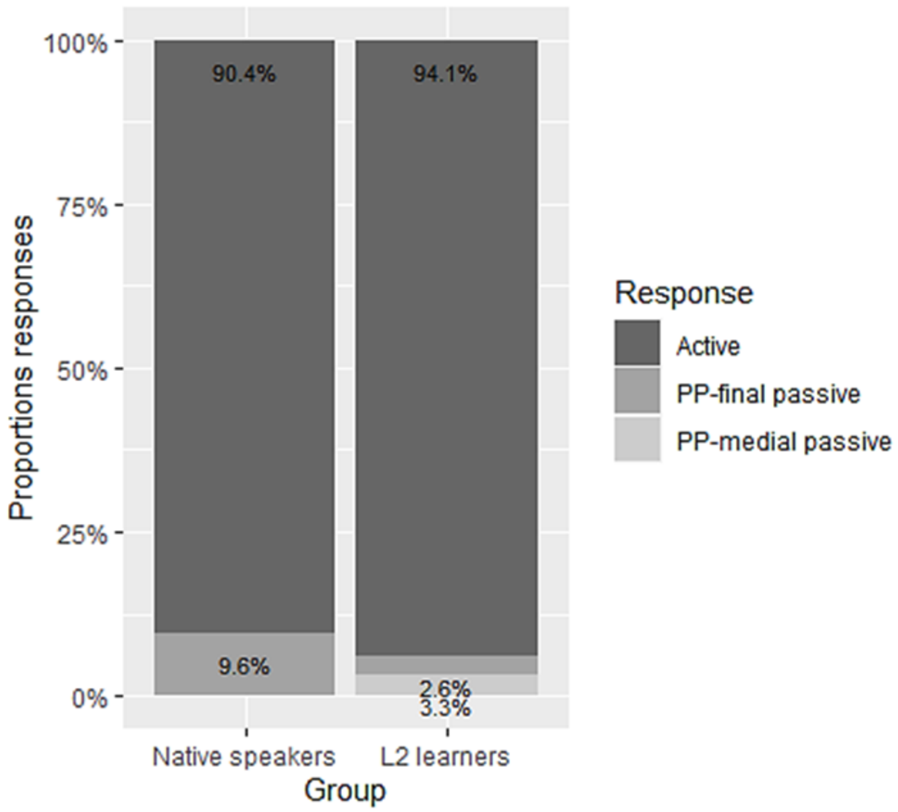

Figure 1 The proportion of unprimed responses in the pre-experimental block for the native speakers (left bar plot) and the L2 learners (right bar plot). The darkest shade of grey indicates the proportion of active responses, the lighter one displays the proportion of PP-final passive responses and the lightest one, the proportion of PP-medial passive responses.

Experimental block

During the experimental block, the native Dutch speakers (44 participants) produced 1,584 responses. There were 214 (13.5%) “Other” responses, of which 81 were actives. Moreover, there were 1,224 (77.3%) PP-final passives and 146 (9.2%) PP-medial passive responses. The learners (92 participants) produced a total of 3,312 responses. There were 1,182 (35.7%) “Other” responses, of which 254 were active responses. The remaining responses were 871 (26.3%) PP-final passives and 1,259 (38%) PP-medial passives (see Figure 2 for the mean PP-medial proportion per prime condition and language group. The “other” responses are excluded). Thirteen L2 learners had to be excluded because they did not produce any PP-medial or PP-final passive responses. Possibly, these excluded participants found it difficult to produce passives (see large percentage [35.7%] of "Other" responses), which are regarded to be complex sentences.

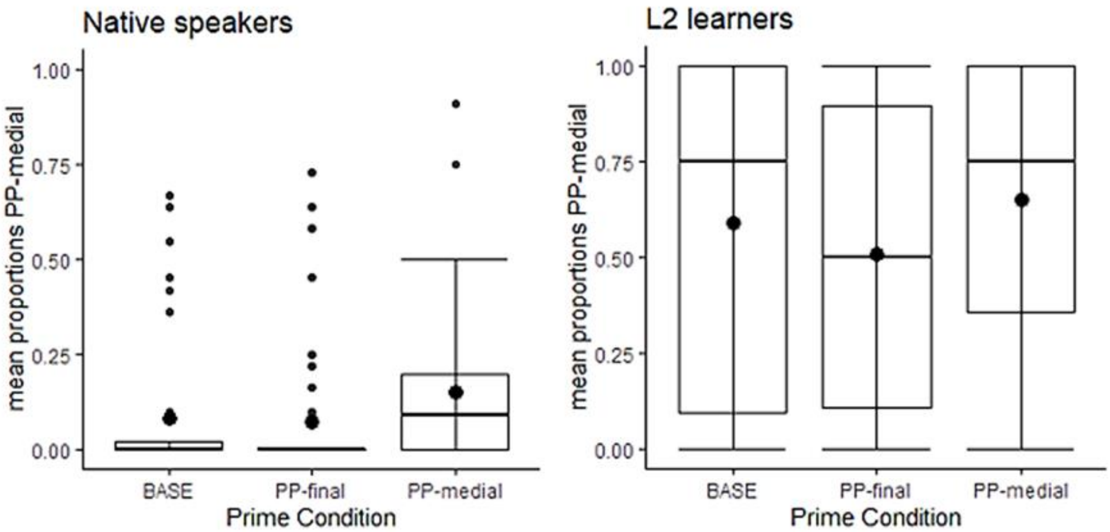

Figure 2 The mean proportion of PP-medial passives per prime condition in the native speakers (left boxplot) and L2 learners (right boxplot). The thick dot indicates the mean and the smaller dots (in the boxplot of the native speakers) indicate the outliers. The thick horizontal line indicates the median value of the PP-medial proportion in each prime condition. The boxplot of the L2 learners indicates more variance in the production of PP-medial passives and a higher mean value, while the boxplot of the native speakers shows less variance and lower mean values in each prime condition. The native speakers only show PP-medial priming, while the L2 learners show priming for PP-final and PP-medial passives.

The full model consisted of an interaction between *Prime Condition* and *Group* (with the native speakers as reference); the maximal random effects structure consisted of *Prime Condition* as a random slope within *participant* and *Prime Condition* and *Group* as random slopes within *item*.

The final model consisted of an interaction between *Prime Condition* and *Group* and random intercepts for *participant* and *item* (see Table 2). The negative estimate for the intercept suggests that, in the baseline condition, the native speakers produced more PP-final passives than PP-medial passives. The native speakers showed no significant PP-final passive priming (b = -0.16, 95% CI [-0.74, 0.42], p = .582), but the PP-medial priming effect (7.4%) (i.e., more PP-medial passive responses after a PP-medial passive prime condition than after a baseline) was significant (b = 1.23, 95% CI 0.71, 1.76], p = .001). The positive estimate for *Group* indicates that the L2 learners produced significantly more PP-medial passives in the baseline condition compared to the native speakers (b = 5.33, 95% CI [4.11, 6.55], p = .001). The interaction between *PP-final passive priming* * *Group* was not significant (b = -0.56, 95% CI [-1.22, 0.09], p = .090), which means that there was no difference between both groups for PP-final passive priming. However, the L2 learners showed significantly weaker PP-medial passive priming than the native speakers (b = -0.72, 95% CI [-1.33, -0.11], p = .021).

Table 2 Best Fit Model for Joint Analysis of the Experimental Block Data (*N* = 3500; log-likelihood = -1180.7)

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	-4.56	0.52	-8.79	<.001
Prime Condition PP-final	-0.16	0.30	-0.55	.582
Prime Condition PP-medial	1.23	0.26	4.58	<.001
GroupL2learners	5.33	0.62	8.58	<.001
Prime Condition PP-final * GroupL2learners	-0.56	0.33	-1.70	.090
Prime Condition PP-medial * GroupL2learners	-0.72	0.31	-2.30	**.021**

Note. Final model = glmer(target response ~ Prime Condition*Group + (1|Participant) + (1|Item), data = DutchFrench, family = binomial)

The effect size (*b*-estimates) for PP-medial passive priming was small and very small for PP-final passive priming as well as for both interaction terms (PP-final passive priming * *Group* and PP-medial passive priming * *Group*) (Chen et al., 2010). However, the effect size for *Group* was very large (odds ratio > = 6.71). The explanatory power of the random effects (conditional R^2 = .81) and the fixed effects (marginal R^2 = .35) part of the model was substantial (see Cohen, 1988).

We found no violations of assumptions (homogeneity of variance and the distribution of residuals). However, we found that participant 131 (a native speaker) strongly influenced the fitted values of our final regression model, and this was noticeable due to their high Cook's distance (see Appendix S3). Participant 131 deviated from the rest of the native speakers, because they showed a very strong PP-*final* priming effect (see Appendix S3), while native speakers, as a group, showed strong PP-medial priming (see Appendix S2). We reran the model without this participant and observed a significant interaction between PP-final passive priming and *Group* (*b* = -0.76, 95% CI [-1.44, -0.07], *p* = .031), which entails that the L2 learners showed stronger PP-final passive priming than the native speakers (see Appendix S3). In addition, the interaction between PP-medial passive priming and *Group* became weaker for the L2 learners compared to the native speakers (*b* = -0.99, 95% CI [-1.64, -0.35], *p* = .002) (see Appendix S3). We decided not to drop this participant from our analysis, since strong priming for PP-final passive may be a legitimate observation in native speakers (even though it is unlikely to occur). We discuss this briefly in the Discussion.

Separate analysis for the L2 learners

The L2 learners (79 participants) produced a total of 2,130 target responses in the experimental block. Of these responses, 871 (26.3%) were PP-final passive responses and 1,259 (59.1%) responses were PP-medial passive responses. Fifty-eight L2 learners produced both passive forms, 14 only produced PP-medial passives and 7 only produced PP-final passives.

Our full model for the L2 learners consisted of an interaction between *Prime Condition* * *Dutch Proficiency;* the maximal random effects structure consisted of *Prime Condition* as a random slope within *participant,* and *Prime Condition* and *Dutch Proficiency* as random slopes within-*item*. Since *Dutch proficiency* is a continuous covariate, this variable was scaled and centered to its mean.

The final model consisted of an interaction between *Prime Condition* and *Dutch proficiency* and random intercepts for *participant* and *item* (see Table 3). In the baseline condition, the learners produced more PP-medial passives than PP-final passives. The learners showed a significant PP-final priming effect of 9.1% (*b* = −0.76, 95% CI [-1.06, -0.45], *p* = .001) and we also found PP-medial priming of 5.3% (*b* = 0.46, 95% CI [0.14, 0.77], *p* = .005). Next to this, there was a significant effect of *Dutch Proficiency* (*b* = −0.89, 95% CI [-1.60, -0.18], p = .015) in the baseline condition: the higher the L2 proficiency, the lower the proportion of PP-medial passives and the higher the proportion of PP-final passives. Interestingly, PP-medial priming was not the same for all participants because there was a significant interaction between *PP-medial priming* and *Dutch Proficiency* (b = 0.37, 95% CI [0.06, 0.68], p = .020). In line with our expectations, PP-medial priming was stronger for the more proficient L2 speakers than for the less proficient L2 speakers (see Figure 3). There was no significant interaction between PP-final priming and L2 proficiency (b = 0.22, 95% CI [-0.09, 0.54], p = .162). Note that, although this interaction was not significant, Figure 3 suggests that PP-final priming was not the same across all proficiencies as well: less proficient bilinguals seem to show stronger PP-final priming than more proficient bilinguals.

Table 3 Best Fit Model for the L2 Learners (N = 2130; log-likelihood = - 875.3)

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	0.92	0.37	2.13	**.033**
Prime Condition PP-final	-0.76	0.15	-4.85	<.001
Prime Condition PP-medial	0.46	0.16	2.84	**.005**
Dutch Proficiency	-0.89	0.36	-2.44	**.015**
Prime Condition PP-final * Dutch Proficiency	0.22	0.16	1.39	.161
Prime Condition PP-medial * Dutch Proficiency	0.37	0.15	2.32	**.020**

Note. Final model = glmer(target response ~ Prime Condition*Dutch Proficiency + (1|Participant) + (1|Item), data = French, family = binomial)

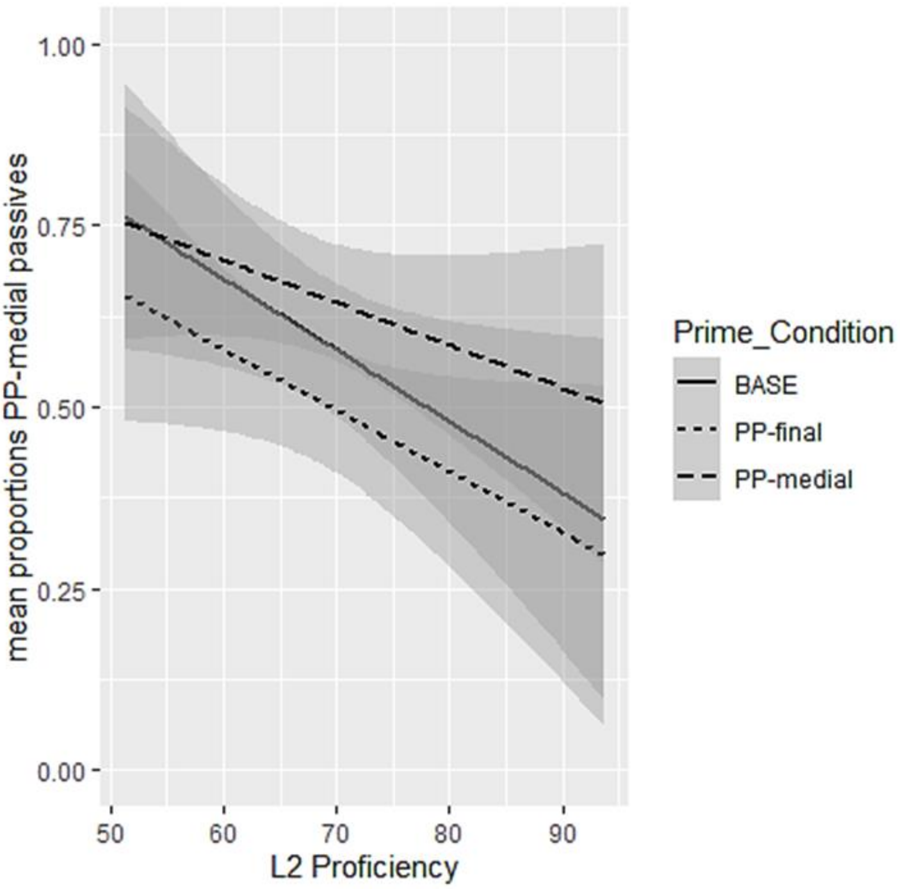

Figure 3 The interaction between prime condition and L2 proficiency. The y-axis represents the PP-medial passive proportion, and the x-axis represents the L2 proficiency scores. The three separate lines represent the prime conditions.

Given the beta estimates, all the effect sizes reported above were very small (see Chen et al., 2010). The random effects of the final model explained 74% of the variance (conditional R^2 = .74, substantial effect; Cohen, 1988). The fixed effects part explained 6% of the variance (marginal R^2 = 0.06, small effect; Cohen, 1988). The large difference between the marginal R^2 and the conditional R^2 indicates that inter-individual differences in outcome are a major source of variance in this dataset.

When we checked for violations of assumptions and influential participants, we found a violation of the distribution of the L2 proficiency residuals. We discovered that the violation of distribution of the residuals was due to participant 30. This participant had a high LexTALE score (93.75) and showed very strong PP-medial priming (see Appendix S4). We reran the final model without participant 30 and observed that the interaction between *PP-medial priming * L2 Proficiency* was no longer significant (b = 0.30, 95% CI [-0.04, 0.63], p = .084, see Appendix S4 for model output). We decided not to drop this participant from our analysis, because a high L2 proficiency and strong PP-*medial* priming are legitimate observations amongst these L2 learners[8]. We discuss this in the Discussion.

4. Discussion

We investigated whether late L2 learners can be primed to produce dissimilar syntactic structures between the L1 and the L2 if a similar syntactic variant is already available in the second language. We assumed that late L2 learners may not produce dissimilar L2 structures *spontaneously*, but we ask whether priming may elicit the production of dissimilar L2 structures, which would indicate that a representation is formed for these structures. We chose to investigate this with Dutch passives (PP-final and PP-medial passives) in late learners of Dutch with L1 French and in native speakers of Dutch. For the native speakers, we assumed that they would show a production preference for the PP-final passive and priming for both passive alternants. For the L2 learners, we hypothesized that we would find PP-final passive priming and no PP-medial passive priming because the learning of this structure might be blocked (see Muylle et al., 2021b) due to the presence of the similar and more frequent PP-final passive. We also expected to find L2 proficiency effects: highly proficient L2 learners would show priming for both passive forms, but lower proficiency speakers would only show PP-final priming and no PP-medial priming (because some of

[8] Since we tested L2 learners, we performed additional exploratory analyses to investigate to which extent learning of the two passive forms occurred during the experiment. We did not find an effect of cumulative priming for both passive forms, but we did find an effect of self-priming for both passive forms. However, this did not affect the interpretations of our results (see Appendix S5 for further elaboration on this).

these L2 speakers are probably still in the process of forming a representation for the PP-medial passive structure).

The native Dutch speakers showed a production preference towards PP-final passives in the baseline condition and significant priming for the PP-medial passive (see Appendix S2). Our results for the native Dutch speakers are in line with the *inverse frequency effect* (Jaeger & Snider, 2013; Hartsuiker & Westenberg, 2000), which states that the less frequent syntactic alternant shows stronger priming than the most frequent syntactic alternant due to surprisal. Because there is a bias towards the production of PP-final passives, speakers are surprised when they are exposed to a PP-medial passive prime sentence, which leads to stronger structural PP-medial priming effects compared to PP-final passives in the native speakers.

Surprisingly, our results of the L2 learners showed a production preference towards the PP-*medial* passive in the baseline condition. This already became clear in the pre-experimental block, in which some learners produced PP-medial passive sentences spontaneously, while the native speakers did not produce a single PP-medial passive. During the experimental block, the L2 speakers showed priming for both passive alternants (the native speakers only showed priming for the PP-medial passive), but PP-final priming was stronger than PP-medial priming. Crucially, based on informal interviews with Dutch teachers, we discovered that the L2 learners had been taught to explicitly use the *PP-medial* passive structure. This explains the production preference for this structure in the baseline condition, the strong priming for the PP-final passive structure and the weaker priming for the PP-medial passive structure.

There are several reasons why language teachers in Wallonia (the French speaking part of Belgium) choose to instruct the PP-medial passive to learners of Dutch instead of the PP-final passive (which is the ‘easier’ variant due to its similarity with the French passive).

Many Dutch grammatical structures end with the past participle [e.g., *Ik heb mijn brood opgegeten* – lit. **I have my bread eaten*, meaning *I have eaten my bread*]. However, in French the past participle almost always follows the main verb, which could lead to mistakes (in Dutch) such as **Ik heb opgegeten mijn brood [I have eaten my bread]*. In French, the translation of the aforementioned sentence is grammatically correct: *J'ai mangé mon pain.* To prevent students from making word order errors, language teachers explicitly instruct their students to place the past participle at the end of the sentence. Language teachers separate Dutch-specific rules as much as possible from French-specific rules (see Appendix S6 for an excerpt of the teaching materials). Note that this strategy does not only apply to the formulation of the passive form in Dutch, as Dutch language teachers apply this teaching method to all syntactic structures in Dutch. In terms of the passive form, however, this strategic teaching method explains the paradoxical production preference towards the PP-medial passive in the L2 learners.

We propose that explicit language teaching flipped the frequency distribution of the two passive alternants in the L2 speakers. A similar effect has been reported by Segaert et al. (2011) who manipulated the relative frequency of occurrence of active vs. passive sentences in their study. When they altered the frequency of passive sentence structures, this changed participants' production bias towards passive sentences (usually, people have a strong preference for active sentences). Under these conditions, structural priming effects were found for both active and passive sentences. Segaert et al. suggested that the relative frequency of two syntactic alternants and the accompanying production bias are important predictors for structural priming effects. Moreover, they claim that this bias is *dynamic* and can be strongly influenced through learning. This claim is in line with our finding of the production bias towards the PP-medial passive structure in the L2 speakers. Kaschak (2007) also reported that participants' experience and exposure to either syntactic alternant (in his experiment, this concerned ditransitives) changes people's production bias. Altogether, though we did not predict the effect of explicit language teaching in our study, our study shows that frequency manipulation of syntactic alternants also happens outside an experimental context and that it affects the production bias of language users.

We also found support for the blocking effect (see Muylle et al., 2021b) in our data, though it was highly influenced by explicit language teaching. Because of explicit language teaching, we observed that the L2 speakers associated the Dutch passive form with the structure of the PP-medial passive first, and for this reason, it was more difficult for them to realize that the PP-final passive representation can be shared with that of the L1 PP-final passive structure. Only the higher proficiency L2 speakers produced the PP-medial passive *and* the PP-final passive, while the learning[9] of the PP-final passive was blocked in the lower proficiency L2 speakers. Because explicit language teaching increased exposure to the PP-medial passive structure amongst the L2 speakers, we suggest that future studies might expand the work on our research question, while taking into account the effects of language teaching on learners' production biases.

Importantly, we found that PP-medial priming was modulated by L2 proficiency in the L2 learners: PP-medial priming became stronger upon increasing L2 proficiency. Because higher L2 proficiency speakers also produced PP-final passive responses in the baseline condition, compared to the lower proficiency speakers, there was a greater window for PP-medial priming to occur (see Figure 3, where the proportion of PP-medial passive responses in the baseline, which is complementary to the proportion of PP-final passives, decreases with an increasing L2 proficiency). In contrast, the lower proficiency speakers almost always produced PP-medial passives, which resulted in very little room for PP-medial priming in

[9] Here, "learning" refers to what the learners have learned prior to completing this experiment. Importantly, "learning" in this context does not mean "learning" from the task.

comparison to the baseline. Therefore, our results suggest that individual differences in L2 proficiency appear to be an important predictor for the priming of dissimilar structures between languages. Note that, descriptively, the less proficient bilinguals seemed to show stronger PP-final priming than the more proficient bilinguals (see Figure 3), even though there was no significant interaction between these variables (see Table 3).

Though the effect of L2 proficiency on PP-medial priming is specific to the group that we tested, who were also exposed to explicit language teaching, our data support previous studies that reported L2 proficiency as an important predictor for structural priming effects in a second language. For instance, Bernolet et al. (2013) primed the use of genitives in a between language experiment (English genitives – Dutch genitives) and a within-English structural priming experiment in late learners of Dutch-English bilinguals with varying levels of L2 proficiencies. In both experiments, Bernolet et al. found stronger priming for more proficient bilinguals than for less proficient bilinguals. Recently, Hwang (2021) investigated to what extent Korean learners of English could be primed to produce causative events in English (e.g., *Joan had her laptop fixed*), which are expressed differently in Korean (e.g., *Joan (NOM) laptop-ACC fixed*). She found that highly proficient Korean learners of English produced more causative sentences than the lower proficiency speakers. In Hwang's study, though, L2 proficiency did not modulate priming effects, she only found a main effect of L2 proficiency on the production of different L2 syntactic structures. We stress that L2 learners can produce dissimilar L2 structures if they are explicitly taught to use these structures, and this determines the production preferences and priming patterns. An important contribution of our work is that we found that the priming of (explicitly taught) dissimilar L2 structures becomes stronger with increasing L2 proficiency. Note that the effect of L2 proficiency on PP-medial priming can also be explained by the assumption that L2 learners' implicit language expectations might change with increasing proficiency (Montero-Melis & Jaeger, 2019). In our case, it is likely that the higher proficiency L2 users encounter the PP-final passive structure more frequently than the explicitly taught PP-medial passive structure. This implies that, with increasing proficiency, these L2 users changed their expectation of the PP-final passive structure and therefore showed stronger priming towards the PP-medial passive.

We would also like to address the additional analyses that we performed based on the outliers: participant 131, a native speaker, and participant 30, an L2 learner. Unlike the rest of the native speakers, who showed strong PP-medial passive priming, participant 131 showed strong PP-final passive priming instead. Participant 30 showed very strong PP-medial passive priming, and it is possible that this participant played an important role in the significant interaction between PP-medial priming and L2 proficiency (see Table 3) in the L2 learners. However, we decided to keep both participants in their respective analyses because their individual data patterns are legitimate observations. Moreover, as far as we know, structural priming studies are based on group level analyses and individual structural priming patterns are usually not part of the inferential statistics. However, our additional analyses show that individual variance amongst participants may be important for how structural priming effects are interpreted.

Altogether, our study suggests that *L2 proficiency* is an important factor for the production of L2 syntactic structures and the priming of these structures (either similar or dissimilar syntactic structures between languages) (see Hartsuiker & Bernolet, 2017).

5. Limitations and Future Directions

A limitation of the current study is that we were not aware of the explicitly taught PP-medial passive structure and its effect on the production bias and priming effects. Because of this, the significant interaction between PP-medial priming and L2 proficiency rather shows the process in which the more proficient learners disengaged from the bias that was taught: at higher proficiency, the proportion of PP-final passives increased, creating room for PP-medial priming. Moreover, our results are specific to Dutch L2 learners with L1 French who are explicitly taught to use one structure over the other and who reside in Belgium. Consequently, it remains to be seen whether the production bias and priming effects would have been different if explicit language teaching was not present in the same group of participants.

Future studies could study other syntactic alternants to answer our research question more accurately. Our research question may be, for example, answered by investigating the production preferences and priming of ditransitives (prepositional object datives and double object datives) between Dutch (PO: *De kok geeft de bal aan de bokser – The cook gives the ball to the boxer*; DO: *De kok geeft de bokser de bal – The cook gives the boxer the ball*) and French (PO [similar structure to Dutch]: *Le cuisinier donne le ballon au boxeur*; DO [there is no identical translation of the Dutch DO variant]: **Le cuisinier donne le boxeur le ballon*). Furthermore, it turned out to be quite difficult for some L2 speakers to produce passives (13 French-Dutch bilinguals only produced ‘Other’ responses and had to be excluded), since this requires conjugating the main verb into a past participle. We believe that simpler constructions, such as ditransitives, may provide researchers with a more accurate answer to our initial research question.

It is important to acknowledge that if we would have found *only* PP-final priming (as we initially proposed) in the L2 learners, it would have been difficult to answer whether this priming effect was solely due to the similarity between the Dutch PP-final passive and the French passive. It is true that the PP-final passive structure is the most frequent passive alternant; thus, structural priming could also have been attributed due to the higher frequency of this structure in the L2 input. We suggest that future research may better answer our initial research question if the L1-L2 similar structure is the *less* frequent option in the L2. In this way, priming of the L1-L2 similar structure can only be attributed to the similarity of a given structure in both languages.

6. Conclusion

This study set out to determine whether late learners of Dutch with L1 French can be primed to produce the dissimilar Dutch PP-medial passive structure, since they can opt to produce the Dutch PP-final passive, which has an identical structure to the French PP-final passive. We found that explicit language teaching has a strong influence on the production preferences and priming effects of Dutch passives in French-Dutch bilinguals. The PP-medial passive is explicitly taught in class, which resulted in a production preference for this structure. The late learners showed strong priming for the PP-final passive structure but weaker PP-medial priming. The PP-medial priming was modulated by L2 proficiency: the number of PP-medial passives decreased in the baseline, while the L2 proficiency increased, and this created room for PP-medial priming. This is probably because the higher proficiency speakers changed their expectation of the PP-final passive structure, such that they showed a similar priming pattern to the native speakers. Though explicit language teaching turned out to be important for our findings, our results fall within recent work on structural priming in bilingual speakers that has centered L2 proficiency as an explanatory variable for the priming of L2 syntactic structures.

CHAPTER 5

USING STRUCTURAL PRIMING TO BOOST THE PRODUCTION OF A LESS PREFERRED L2 SYNTACTIC STRUCTURE

All data, analysis code, and experimental lists are available at

https://osf.io/3nt8r/?view_only=04229f6def2e47a0b2bd8d5f54d302d5

Abstract

This study builds on the results of Sijyeniyo et al. (Chapter 4), who investigated abstract structural priming within Dutch passive alternants (PP-final passives: "*De man wordt **gevolgd door** de hond*" - "The man is being followed by the dog" and PP-medial passives: "*De man wordt **door** de hond **gevolgd***" – *The man is by the dog being followed") amongst late learners of Dutch with L1 French. They found that explicit language instruction affected the production preferences of L2 learners such that they showed a paradoxical preference towards the dissimilar PP-medial passive, which does not exist in French, rather than the similar PP-final passive ("*Le home est **suivi par** le chien*"). Sijyeniyo et al. had three prime conditions (baseline, PP-final, and PP-medial) that equally comprised 1/3 of the primes. They found *stronger PP-final* priming than PP-medial priming relative to the baseline. Moreover, they observed that PP-medial priming was stronger in the higher proficiency bilinguals compared to the lower proficiency bilinguals. Here, we increased the proportion of PP-final passive primes to 50% (vs. 33.33% PP-medial passive primes and 16.67% baseline items) to boost its usage during the description of target pictures. We found that learners produced more PP-final passives in the baseline condition. Moreover, we observed *stronger PP-medial* priming than PP-final priming. Furthermore, PP-final priming was weaker for advanced bilinguals than for less advanced bilinguals, because the proportion of PP-final passives in the baseline condition increased together with participants' proficiency. We suggest that our manipulation may be useful to L2 teaching practices, especially when L2 learners are confronted with learning dissimilar L2 syntactic structures.

***Keywords*:** L2 structural priming, boosting dissimilar L2 syntactic structures, L2 proficiency

1. Introduction

When learning a second language (L2), learners can sometimes depend on their first language (L1) syntactic knowledge to formulate an L2 syntactic structure, whenever the structure between the L1 and L2 is similar. For instance, learners of Dutch with L1 French may use their L1 syntactic knowledge to formulate a passive sentence, because this structure is similar between both languages ("*Le garçon est embrassé <u>par la fille</u>*" – "*De jongen wordt gekust <u>door het meisje</u>*" [The boy is being kissed by the girl]). In this passive form, which we refer to as the PP-final passive, the prepositional by-phrase is placed at the end of both sentences. An L2 may, however, also have syntactic structures that do not occur in the learner's L1 at all. For these *dissimilar* L2 syntactic structures, the learner cannot depend on their L1 syntactic knowledge in the initial stages of L2 syntactic acquisition because there is no similar L1 structure available to the learner (Hartsuiker & Bernolet, 2017). Hence, for these dissimilar L2 structures, second language learners need to develop and establish structural representations. This process can be enhanced by sufficient L2 input and interaction with native speakers (or more proficient L2 learners) of that second language (Gass et al., 1998). For instance, a learner of Dutch with L1 French learns that the similar PP-final passive structure is the preferred passive form in Dutch, due to its frequency of usage (see Cornelis, 1997). Next to this, they learn that there are two other Dutch passive forms that do not exist in French. Namely, in Dutch, the prepositional by-phrase may be placed in the middle of the sentence "*De jongen wordt <u>door het meisje</u> gekust*" – "**Le garçon est <u>par la fille</u> embrassé"* [*The boy is by the girl being kissed"] (PP-medial passive), or even at the start of a sentence "*<u>Door het meisje</u> wordt de jongen gekust*" - "*By the girl is the boy being kissed" (PP-initial passive). Because of increasing contact with the L2, the learner learns that PP-medial passives are more often used than PP-initial passives[1]. Since the PP-medial passive structure does not exist in French, the learner will have to develop and establish a structural representation for this structure before they can use it for L2 syntactic production. While L2 syntactic structures may be learned through sufficient L2 input and interaction with native speakers (or L2 proficient bilingual speakers) of that language, these structures may also be learned through explicit language teaching in an L2 classroom. However, learning L2 syntactic structures by means of explicit language teaching may sometimes influence the structural preferences of L2 learners. Sijyeniyo et al. (Chapter 4) found that explicit language instruction of Dutch passives affected the production preferences of learners of Dutch with L1 French. The French-Dutch bilinguals in their study were explicitly taught to use PP-*medial* passives for the formation of a passive structure in Dutch. This shifted the learners' production preference towards the dissimilar PP-medial passive structure, which did not coincide with the preference that one would expect knowing that there is a similar (and frequent) L1-L2 PP-final passive structure available to the learners.

The study reported here seeks to investigate whether the explicitly taught bias for the PP-medial passive might change if learners of Dutch with L1 French receive an *increased* input of the less preferred PP-final passive structure in prime sentences. Investigating this might provide us insights into what happens to explicitly learned L2 structural preferences when L2 learners are exposed to input that mirrors the frequency distribution of syntactic alternants found in that language. We employ a *structural priming* experiment to answer this research question.

[1] The PP-initial passive is a valid passive Dutch structure, but it is rarely used. Bernolet et al. (2009) collected frequency data on the use of transitives, and in their pre-test, PP-initial passives were not produced, indicating that this structure is indeed not often used in spoken language. In this study, we only focus on PP-final and PP-medial passives.

Structural Priming: A Method to Prime the Production of Less Preferred Structures

Structural priming is the process by which the processing of syntactic structures is facilitated by previously encountering the same syntactic structure, and, usually, researchers use comprehension-production tasks to investigate this (Bock, 1986). For instance, speakers will be more likely to produce a passive target structure ("The boy is being kissed by the girl") upon hearing a passive prime structure ("The cat is being followed by the dog") than when they have heard its active counterpart ("The dog follows the cat"), given that speakers have a representation for the structure in question. To explain structural priming effects, two theories have been proposed in the L1 literature: the lexicalist residual activation account (Pickering & Branigan, 1998) and the implicit learning account (Chang et al., 2000; Chang et al., 2006). The lexicalist residual activation account emphasizes the role of lexical representations during the selection of syntactic structures. According to the predictions of this account, priming occurs due to short-term residual activation of the lexical representation of a verb (e.g., to kiss) and the structural representation in which "kiss" occurs (e.g., a passive) (Pickering & Branigan, 1998). Moreover, the link between the lexical representation and the syntactic representation is strengthened when both representations are activated. The accumulated residual activation that results from this incites speakers to reuse the same syntactic structure (e.g., a passive), even when they encounter a different verb (e.g., to follow). However, when there is verb overlap between the prime and target sentence, language users will demonstrate a stronger tendency to repeat the same syntactic structure. This is because the link between the lexical and syntactic representation is strengthened to an even greater degree so that more activation spreads to the syntactic representation, this is the so-called *lexical boost effect* to structural priming (Pickering & Branigan, 1998). The residual activation is short-lived (with and without lexical overlap) in the sense that it diminishes when the prime and target sentence do not immediately follow each other (Bernolet et al., 2016).

Unlike the residual activation account, the implicit learning account (Chang et al., 2006) predicts that structural priming relies on an error-and prediction-based learning mechanism, in which prediction errors experienced during syntactic processing result in changes in the weights given to a structure. That is, based on a previously comprehended word, the error-driven learning mechanism generates predictions about the next word in an utterance. For example, if a speaker encounters a passive sentence when they were expecting an active sentence, their language processing mechanism will detect an error after they have processed the passive verb form, and it will adjust the weights of the passive structure as a result of failing to predict the sentence. Syntactic learning happens because people experience a mismatch between syntactic predictions and the syntactic structures they actually encounter during processing. The stronger the prediction error that occurs during syntactic processing, the larger the adaptation to the syntactic representation of the given syntactic structure. Consequently, less frequent structures (e.g., passives) induce a larger prediction error than more frequent structures (e.g., actives). This entails stronger structural priming for less frequent structures than for more frequent ones, a phenomenon called the *inverse-frequency effect* to structural priming (Hartsuiker & Westenberg, 2000; Jaeger & Snider, 2003; Ferreira & Bock, 2006). Note that the adjustment of weights in response to the error caused by the unexpected passive sentence will increase the likelihood of the language processing mechanism correctly predicting passive sentences in subsequent sentences. Importantly, the implicit learning account does not predict a lexical boost effect, as implicit learning is assumed to only concern changes to *abstract* syntactic processes, which take place outside the mental lexicon (see Chang et al., 2006; Hartsuiker et al., 2008). Put differently, according to the implicit learning account, lexical overlap between prime and target sentences does not enhance the strength of structural priming.

Structural priming has also been employed in bilingual speakers, and researchers have found that cross-language priming takes place between sufficiently similar syntactic structures in both languages of a bilingual (Hartsuiker et al., 2004). Building on the predictions of the residual activation account, Hartsuiker et al. suggested that, in bilinguals, the activation of lexical and syntactic representations in one language induces activation of translation equivalents and shared[2] structures in the other language (see Van Gompel & Arai, 2018, for a review on cross-language priming). The implicit learning account has not yet been extended to bilingual speakers. However, recently, Khoe et al. (2021) have implemented and tested a bilingual version of the implicit learning account by means of language models, showing that error-driven learning plays a crucial role in L2 syntactic learning.

With the aforementioned in mind, if a late L2 learner has the choice to produce a target sentence with an L1-L2 similar syntactic structure or with an L2 dissimilar syntactic structure, it is likely that they will choose the L1-L2 similar structure, as they can make use of the shared syntactic representation between the L1-L2 to produce the L2 syntactic structure. Moreover, if the L1-L2 similar structure is the most occurring alternant in the L2, second language learners will have probably encountered this structure more often than the dissimilar and less frequent L2 structure. Furthermore, since the learning experience of speakers shapes their subsequent language use (Chang et al., 2006), this raises the odds for choosing the L1-L2 similar structure over the dissimilar L2 structure even more. This, however, does not imply that L2 learners do not have a syntactic representation for the dissimilar L2 structure, as they might have developed a representation for this structure in comprehension (e.g., during L2 reading). In this case, structural priming is a suitable method to elicit less frequent L2 alternatives that may not be produced spontaneously, especially if

[2] "Sharing" means that there is one syntactic representation, for instance, for the PP-final passive in French and Dutch, which is connected to all transitive verbs in a bilingual's memory.

there is a similar L1-L2 structure available to the bilingual. If priming occurs for dissimilar (and perhaps less frequent) alternatives that are not produced spontaneously, one can assume that language users have a mental representation for that syntactic structure (Pickering & Ferreira, 2008).

While L1 syntactic acquisition occurs on the basis of implicit learning processes, L2 syntactic acquisition differs[3] from L1 syntactic acquisition, since L2 syntactic structures are often learned by means of explicit instruction (Ellis, 2005). In the L2 classroom, a conscious effort is made to teach (new) L2 syntactic structures to learners. It has been claimed that explicit instruction is more effective for L2 syntactic learning than implicit learning, as explicit instruction can speed up the learning process (Norris & Ortega, 2000). Specifically, in an L2 classroom, learners are often presented with grammar rules of (complex) L2 syntactic structures and the explanation that is required to understand these rules, whereas during implicit learning, it may take a while before learners learn to produce these (complex) L2 syntactic structures themselves (DeKeyser, 2003). But what happens in the situation where second language instructors provide explicit instructions to use one L2 syntactic alternant over another, such that these instructions do not coincide with the structural preferences that one would expect based on the above discussed theoretical predictions (L1-L2 syntactic similarity and frequency of usage)?

Sijyeniyo et al. (Chapter 4) investigated the production preferences and abstract structural priming (i.e., priming without lexical overlap) of PP-final and PP-medial passives amongst learners of Dutch whose L1 was French. In their within Dutch structural priming experiment, the proportions of PP-medial passive primes, PP-final passive primes and the baseline condition (see Bernolet et al., 2009 who also used a baseline) were equally

[3] Of course, there are many more differences between L2 syntactic acquisition and L1 syntactic acquisition (see e.g., Ullman, 2001, for more on this topic).

distributed. That is, the total number of primes consisted of 36 items, and thus each condition consisted of 12 prime items (33.33%). Based on the structural similarity of the PP-final passive between French and Dutch, and the frequency distribution of PP-final and PP-medial passives in Dutch, Sijyeniyo et al. assumed that, in the baseline condition, the learners of Dutch would prefer to use a PP-final passive over a PP-medial passive for the formulation of a target sentence. Moreover, Sijyeniyo et al. anticipated PP-final priming, as the French native speakers could use the shared PP-final passive representation to produce the Dutch PP-final passive structure. The authors did not expect PP-medial priming because the learners could have still been in the process of forming a representation for this structure. They speculated that only very proficient learners of Dutch would show PP-medial priming, as L2 proficiency has been found to be an important predictor for the priming of L2 syntactic structures (Bernolet et al., 2013; Hartsuiker & Bernolet, 2017). Contrary to their expectations, Sijyeniyo et al. found that the French-Dutch bilinguals had a production preference for PP-*medial* passives in the baseline condition. Through informal interviews with some of the participants' Dutch language instructors, the researchers discovered that the learners had been explicitly taught to use the PP-medial passive for the formulation of a Dutch passive[4] sentence. Consequently, explicit language teaching flipped the frequency distribution of the two passive alternants, in favor of the dissimilar PP-medial passive structure. This observation suggests that production biases reflect the language input that learners receive. Sijyeniyo et al. reported priming for both passive forms, but PP-final priming was stronger than PP-medial priming, which is in line with the inverse-frequency effect (Chang et al., 2006). The fact that priming was observed for both passive forms indicates that the learners

[4] Informal interviews with the Dutch language instructors in Sijyeniyo et al. (Chapter 4) revealed that they instruct their students to place past participles at the end of sentences. They do this to prevent the learners from making word order errors in Dutch that may occur due to L1 (French) syntactic transfer errors (e.g., *Ik heb <u>opgegeten</u> mijn brood – correct in French: *J'ai <u>mangé</u> mon pain* [I have eaten my bread]). French places the verbs together, while Dutch places phrases between the auxiliary verb and the past participle. We refer to Sijyeniyo et al. for an elaboration on this.

had established a syntactic representation for the similar and dissimilar L2 syntactic structure. Moreover, the combination of a preference for PP-medial passives in the baseline condition together with stronger PP-final priming than PP-medial priming suggests that the base rates in which syntactic alternants occur is an important predictor for the strength of structural priming. Lastly, Sijyeniyo et al. found an effect of L2 proficiency in the baseline condition: the proportion of PP-final passives in the baseline condition increased together with participants' proficiency; as such, advanced bilinguals showed stronger PP-medial priming than less advanced bilinguals. The higher proficiency bilinguals had probably learned that the PP-final passive is the preferred passive form amongst native Dutch speakers. As L2 proficiency seemed to have affected the production preferences and the structural priming effects, this suggests that preferences are not static but are rather *dynamic*, as they are subject to learning *(*cf. Segaert et al., 2011).

If production preferences are indeed *dynamic*, one may wonder whether preferences can change within a structural priming experiment in which the language input is manipulated to reflect an L1 production preference. Though it has been reported that structural priming fosters L2 syntactic acquisition (McDonough & Mackey, 2008), as far as we know, there have been no studies in the L2 structural priming literature that have *increased* the input of a less preferred L2 structure in prime sentences to promote its usage in target sentences amongst second language learners.

There are only a few L1 structural priming studies that have manipulated the frequency distribution of syntactic alternants to investigate the extent to which this affects the rates at which one (or both) of the alternants are produced in subsequent language use, and the extent to which this affects the strength of structural priming (Kaschak et al., 2006; Kaschak, 2007; Segaert et al., 2011). In an experiment involving psychology students, Kaschak et al. (2006) investigated how recent experience with datives (direct object datives

[DO: "John gave his girlfriend…"] and prepositional object datives [PO: "John gave a gift…"]) affects the strength of structural priming for these constructions. Their priming experiment comprised a written sentence completion task, and they always used lexical overlap between prime and target trials. The experiment was conducted in two phases: *the recent experience phase* and *the priming phase*. Participants were divided into three groups depending on the exposure manipulation in the recent experience phase. In the "Equal Exposure" condition, participants alternatively saw either a DO ("Mary gave her mother…") or a PO ("Mary gave a gift…") that had to be completed. Both constructions were offered equally often, so the distribution was 50/50, like in most structural priming experiments. Participants in the "Equal Exposure-Block" condition also saw an equal number of DO and PO constructions that had to be completed, but one construction appeared entirely in the first half of the recent experience phase, and the alternative construction appeared during the second half of this phase. Lastly, in the "Unequal Exposure" condition, participants had to complete sentences in only one construction (either a DO or a PO). Right after the recent experience phase, participants moved on to the *priming phase* of the experiment. In this phase, participants were presented with primes for only one type of construction (either a DO or a PO). For the target sentences, participants had to complete a sentence, but they could choose either structure (e.g., "Kim gave…"). The researchers found that if participants' recent experience was heavily biased towards one construction (e.g., the DO), participants showed *weaker* structural priming for the alternative construction (PO) in the priming phase, an observation that does not coincide with the inverse-frequency effect. Kaschak et al. also found that if participants produced an equal number of DO and PO constructions in the recent experience phase, priming effects were the same regardless of whether the DO and PO structures were alternated or whether the DO and PO structures were presented in blocks. This result suggests that the effects of relative frequency on structural priming are not affected by where constructions appear within an experiment (i.e., whether constructions are presented alternatively or whether they are presented in blocks).

In 2007, Kaschak included a norming study prior to replicating the experiments in Kaschak et al. (2006). This norming study was necessary as it has been found that language users have a base rate preference for one structure over another. For instance, English native speakers have a production preference for the DO construction[5] (see e.g., Bock & Griffin, 2000), even before they have gone through a bias manipulation. The norming study showed that participants indeed had a production preference for the DO structure. In his replication experiment in which participants were equally exposed to DO and PO constructions (50/50 exposure condition), Kaschak (2007) found an increase of PO constructions, relative to proportion of PO constructions in the norming study. This implies that repeated exposure to DO and PO datives in prime sentences only affected the pattern of PO target completions (the less frequent alternant), such that more POs were produced after the bias manipulation compared to the proportion of POs in the norming study. However, PO priming was not stronger than DO priming, which does not corroborate the inverse-frequency effect. Kaschak's results (et al., 2006; 2007) can be partly explained by the implicit learning account in the sense that this account is sensitive to the relative frequency with which syntactic structures are used. Repeated use of a particular syntactic structure (e.g., exposure to only DOs) strengthened the representation of that structure such that the learning mechanism was 'tuned' to generate the same construction in subsequent trials, and for this reason, participants produced the alternative construction (POs) less often. Hence, stronger priming was observed for the DO construction, and weaker priming for the alternative PO construction. Thus, the results of Kaschak imply that priming effects are affected by the relative frequency with

[5] However, Corley and Scheepers (2002) report a bias towards POs in native English speakers. Moreover, Van Lieburg et al. (under review) also report a PO bias in native speakers of English.

which constructions have been recently experienced by language users. The priming pattern found in both studies of Kaschak, however, does not corroborate the inverse-frequency effect: if there is a preference towards a specific syntactic alternant (DO), usually, researchers report *stronger* priming for the alternative structure (PO) that occurs less frequently in the input (Chang et al., 2006).

Next to Kaschak's (et al., 2006; 2007) work, there is a study by Segaert et al. (2011), who had two groups (a control group and an experimental group both consisting of native speakers of Dutch) perform a structural priming experiment that included active and passive prime-target trials with- and without verb overlap. Prior to the structural priming experiment, which employed a picture description paradigm, participants completed a training session in which they described color-coded pictures with transitive verbs. In the training session, the control group produced 90% *active* descriptions and 10% *passive* descriptions, which mirrors the frequency distribution of these transitives in most languages. The experimental group produced 90% *passive* descriptions and 10% *active* descriptions. After the training session, both groups performed the structural priming experiment. Segaert et al. found that the production of passives was boosted in the experimental group compared to the control group. The control group produced 10.5% passives in the baseline condition, whereas the experimental group produced 18.8% passives after a baseline condition. The control group showed passive priming (with and without verb overlap), and weak active priming was only found in the trials *without* verb overlap. Importantly, for the experimental group, the researchers found priming for passives and actives in all conditions, suggesting that changes in the frequency distribution of two syntactic alternants affect structural priming effects. Interestingly though, in the experimental group, abstract active priming (i.e., priming without lexical overlap) was *stronger* than abstract passive priming, while lexically-based active and passive priming were equally strong. It is likely that participants' experience with a higher proportion of passive sentences in the training session only affected the strength of *abstract* priming and not the strength of lexically-based priming. This corroborates the predictions of the implicit learning account, which states that priming will be greater for constructions that are offered less frequently in the experiment, and that learning is assumed to only concern changes to *abstract* syntactic processes (see Chang et al., 2006; Hartsuiker et al., 2008). This may explain why equally strong lexically-based passive and active priming were observed for the experimental group.

In the next section, we propose that a similar intervention method, namely, increasing the number of primes of one syntactic alternant over another, may be used in L2 structural priming too.

Current Study: Employing Structural Priming to Boost the Production of a Less Preferred L2 Syntactic Structure

In this study, we propose that increasing the input of a less preferred L2 syntactic structure in primes may be an intervention method that can boost the production of this structure in target trials amongst second language learners. In fact, recently, there has been a structural priming study that has used a different intervention method to increase the production of a less preferred L2 syntactic structure in the subsequent language use of L2 learners. Van Lieburg et al. (Chapter 2), who investigated active and passive priming in beginning learners of Dutch, found that using verb overlap in only a few passive sentences half-way through their structural priming experiment boosted the production of passives in subsequent trials without such overlap. In our experiment, we do not use lexical overlap between prime and target trials. Instead, in the current study, we increase the proportion of PP-final passive primes to 50% (18 items) (the proportion of PP-final passive primes was 33.33% in Sijyeniyo et al., Chapter 4), while the proportion of PP-medial passives remains at 33.33% (12 items, analogous to Sijyeniyo et al.). In addition, we lowered the baseline items in this study to 16.67% (6 items) (the baseline items in Sijyeniyo et al. were 33.33% of the input). We chose to use the same number of PP-medial primes as in Sijyeniyo et al., but we changed 6 baseline items from Sijyeniyo et al. into PP-final passive primes for this study, so that any effect would only be attributable to the manipulation in the PP-final passives primes and in the baseline items. Even though Sijyeniyo et al. observed that their Dutch learners with L1 French had a production preference for PP-*medial* passives in the baseline condition, we still employed a baseline in this study because it would allow us to determine whether one or both primes affect the learners' syntactic preferences relative to the baseline. Moreover, a baseline condition allows us to compare the proportion of PP-final passive responses in the different conditions compared to the proportion of PP-final passives in the same conditions in Sijyeniyo et al.

Because of our frequency manipulation, we anticipate a production preference for PP-final passives in the absence of a prime sentence. As a result, we predict stronger PP-medial priming than PP-final priming in learners of Dutch with L1 French (following the predictions of the implicit learning account). In addition, we expect an L2 proficiency effect in our baseline condition: because the proportion of PP-final passive sentences in the baseline condition will presumably increase upon L2 proficiency, PP-medial priming will be stronger for more advanced bilinguals than for less advanced bilinguals. At the end of our study, we ask participants to rate the PP-medial, the PP-final and the PP-initial passive on how correct they believe each passive form is. The ratings are based on a 7-point Likert scale ranging from very bad, corresponding to a score of 1, to very good, corresponding to a score of 7. This will provide us more insights into whether the PP-final passive may have been considered incorrect by the learners of Dutch, since they have been explicitly taught to use the PP-medial passive for the formulation of a Dutch passive sentence.

2. Method

2.1. Participants

We recruited 33 learners of Dutch with L1 French through Dutch language teachers at different universities in Wallonia (Belgium) and through social media. The participants' L1 could only be French; they had to be sequential learners of Dutch and they had to have acquired Dutch outside a home context (i.e., in kindergarten, Dutch immersion school, Dutch courses etc.). Due to these criteria, we had to exclude two participants in our dataset, because they spoke another L1 next to French (one bilingual listed Italian as their additional L1, and another bilingual spoke Vietnamese as an L1). For this reason, the analysis and the results comprise the data of 31 late learners of Dutch with L1 French (20 females and 11 males), who had a mean age of 23.06 years (*SD* = 3.31, 95% CI [21.84, 24.28], range = 18-30). All participants provided written consent before participating in this study.

At the end of our priming experiment, participants performed the Dutch version of the LexTALE language test (Lemhöfer & Broersma, 2012) and they were also asked to fill out a language questionnaire (a short version of the LEAP-Q, *Language Experience and Proficiency Questionnaire*, adapted from Marian et al., 2007). The most important information from the LEAP-Q and the LexTALE scores is presented in Table 1. In the questionnaire, they answered questions such as 'at what age did you learn Dutch?' and 'where did you learn Dutch?' They were also asked to rate their proficiency in Dutch in production and comprehension on a 7-point Likert scale ranging from very bad, corresponding to a score of 1, to very good, corresponding to a score of 7. There was no correlation between the self-rated proficiency value for Dutch production and the LexTALE scores $r(29) = .22$, $p = .23$[6]. There was also no correlation between the self-rated proficiency value for Dutch comprehension and the LexTALE scores $r(29) = .27$, $p = .132$). The

[6] Note that the self-rated proficiency scores and the LexTALE scores were moderately correlated in Chapter 4.

participants in this study were almost as proficient (*M* =67.69, *SD*=12.17) in Dutch as the ones in Sijyeniyo et al. (Chapter 4) (*M*=67.32, *SD*=9.96) (LexTALE scores between 60% and 80% correspond to an upper intermediate level/B2 level, see Lemhöfer & Broersma, 2012).

PP-final, PP-initial, and PP-medial Passive Ratings by the Participants

In the last question of the LEAP-Q (thus at the end of our study), participants were asked to rate how correct the following three passive sentences were according to them (based on a 7-point Likert scale): "*De zeppelin wordt achtervolgd door het vliegtuig*" – The zeppelin is being chased by the plane (PP-final passive), "*Door het vliegtuig wordt de zeppelin achtervolgd*" - *By the plane is the zeppelin being chased (PP-initial passive) and "*De zeppelin wordt door het vliegtuig achtervolgd*" - *The zeppelin is by the plane being followed (PP-medial passive). We did not include the words "passives" and "grammar" in our rating task because we did not want to influence participants' judgement on the three sentences. We added the PP-initial passive as a distractor so that the distinction between the PP-final and PP-medial passive would not be entirely obvious. Due to the explicit teaching of the PP-medial passive, it could be that the learners, especially the lower proficiency ones, consider the PP-final passive to be *incorrect*, because they might be unfamiliar with this structure.

Based on the descriptive values for the ratings of the three passive forms (Table 1), the mean rating of the PP-medial passive structure is the highest (6.61), indicating that participants rated this structure as the most correct one. The mean rating of the PP-final passive structure (5.77) is lower than the one for the PP-medial passive, but the difference between both ratings is small, indicating that the PP-final passive was probably considered correct too. The mean rating of the PP-initial passive (3.74) suggests that participants believe this structure to be the least correct passive form. Also, the standard deviation in the rating of the PP-medial passive structure is the smallest, implying that there was little variance in participants' judgement for this structure. After completing the rating task, participants received a gift voucher in exchange for their participation.

Table 1 Information on the Participants

	M *(SD)*	95% CI [,]	Range
Participants (N=31)			
Onset of Dutch acquisition	9.33 (4.86)	[7. 55, 11.12]	2.5 – 21.0
LexTALE score	67.69 (12.17)	[63.22,72.15]	41.25 – 87
Self-rated Dutch proficiency: production	4.93 (1.12)	[4.52, 5.34]	2.0 – 7.0
Self-rated Dutch proficiency: comprehension	5.68 (1.14)	[5.26, 6.09]	3.0 – 7.0
Rating PP-*final* passive: De zeppelin wordt achtervolgd door het vliegtuig. [The zeppelin is being chased by the plane]	5.77 (1.48)	[5.23, 6.32]	2.0 – 7.0
Rating PP-*initial* passive: Door het vliegtuig wordt de zeppelin achtervolgd. [*By the plane is the zeppelin being chased]	3.74 (2.03)	[2.99, 4.49]	1.0 – 7.0
Rating PP-*medial* passive: De zeppelin wordt door het vliegtuig achtervolgd. [*The zeppelin is by the plane being chased]	6.61 (0.99)	[6.25, 6.97]	3.0 – 7.0

Note. The values for age of acquisition and the age in which participants first learned Dutch in school were the same (third row).

2.2. Materials and Design

We used the same materials as Sijyeniyo et al. (Chapter 4), which comprised black-and-white line drawings adapted from Bernolet et al. (2009) and included pictures from the International

Picture Naming Project (Bates et al., 2003) depicting transitive and intransitive events. The Dutch verb describing the (in)transitive event was displayed at the bottom of the pictures.

Pre-experimental Block

We used a pre-experimental block to assess participants' spontaneous sentence production preferences for transitives in the absence of a prime sentence. This block consisted of a description set with 24 pictures: 12 pictures displayed transitive events and the other half displayed intransitive events.

Experimental Block

The experimental block was used to investigate abstract structural priming of PP-final and PP-medial passives. The experimental block consisted of 108 sentences, 108 verification pictures, and 108 target pictures. We used 36 prime sentences (out of the 108 sentences) for our three conditions: 18 primes were PP-final passives (*e.g., De hond wordt achtervolgd door de kat* [The dog is being followed by the cat]) (50% of the items), 12 primes were PP-medial passives (*e.g., De hond wordt door de kat achtervolgd* [*The dog is by the cat being followed]) (33.33% of the items), and 6 items were baseline items (16.67% of the items), consisting of conjoined noun phrases (*de hond en de kat* [the dog and the cat]) (see Bernolet et al., 2009). Importantly, note that the prime sentences are not equally divided across the three conditions (see Current Study).

The rest of the sentences (out of the 108 sentences) were 72 fillers: 48 could be described with intransitive verbs and the other 24 with transitive verbs in the *active voice*. We included active sentences as fillers in the hope that this would further mask the occurrence of passive sentences in the critical prime sentences. All 108 sentences were recorded into separate audio files. We asked a different French-Dutch bilingual than the one in Sijyeniyo et al. (Chapter 4) to record all (prime) sentences, because this study used more PP-final passive primes. Though the prime sentences were recorded by a different speaker, we made sure she had a similar profile to the speaker who recorded the sentences in Sijyeniyo et al. (i.e., we chose a female French-Dutch speaker, who was in her early twenties[7]). We do not believe that a different bilingual speaker will influence the results of the current study compared to Sijyeniyo et al., since we test response tendencies (either the production of PP-final or PP-medial target sentences) and not, for instance, response latencies.

We used 108 pictures for the verification set, which was employed as a distractor task to the prime sentences. Half of all the verification pictures matched the prime sentences and the other half did not match the prime sentences. Sixty verification pictures showed transitive verb events and 48 pictures depicted intransitive verb events.

We had 108 pictures that were used for the target description set. Thirty-six pictures were experimental target pictures that could be described with transitive verbs (they showed an agent and a patient, and a Dutch transitive verb). In the target pictures, the patient was indicated by a red frame. We did this because participants were given the task to start their target sentence production with the object in the red frame (for passives, this object is thus the patient). In this way, we elicited a passive response from the participants, which could either be a PP-final or a PP-medial structure. There were also 72 filler items. Twelve of these fillers used conjoined noun phrases, in which the verb was omitted, but the patient was still red-framed. Thus, the pictures with conjoined noun phrases only differed from the other target items based on the absence of a transitive verb. We added the noun phrases so that participants would not only hear them as baseline items but would also produce them in the target pictures. We used 36 fillers to elicit the production of *active* sentences by means of framing the *agent* in a red frame. The remaining 24 filler items were actions that could be

[7] There is some evidence that gender plays a role in the adaptation (also coined by some as *alignment* or *linguistic accommodation*, see Hilte et al., 2020) of linguistic behavior.

described with intransitive verbs. Because these pictures only had one object, we did not use a red frame.

The prime-target pairs were pseudorandomly mixed with the filler items. Each prime and target pair was followed by either one, two, or three filler items. We created 12 lists for our experiment. Across the first 6 lists, each item occurred three times in the PP-final prime condition, two times in the PP-medial prime condition, and once in the baseline condition (within lists, there were 18 PP-final passives, 12 PP-medial passives and 6 baselines). In the last 6 lists, we mirrored the position of the patient compared to the first 6 lists (either left or right[8]). We programmed the experiment in *PsychoPy* v.3.2.4 (Peirce et al., 2019). We embedded the Dutch LexTALE language test in the Psychopy experiment. The experiment was run on the online platform Pavlovia, and this was embedded in a Qualtrics (Qualtrics, Provo, UT) survey, which contained the instructions, the request to provide informed consent, some demographic questions (age, gender, language background), the LEAP-Q questionnaire, and the rating of the three passive forms.

2.3. Procedure

Unlike the participants in Sijyeniyo et al. (Chapter 4) who were tested in a lab, the participants in this study performed the structural priming experiment remotely (online), and we used Microsoft Teams for this. Because of the COVID-19 pandemic, lab testing was not possible. The researcher and the participant scheduled when they would be both available through an online calendar. On the day and time of testing, the researcher sat in front of their

[8] We mirrored the position of the patient in our lists because Sijyeniyo et al. (Chapter 4) constructed their lists in the same way. Since previous studies have depicted patients on the left side of target pictures to increase the odds for a passive sentence (see Bernolet et al., 2009), Sijyeniyo et al. aimed to control for a potential confound in passive sentence production by manipulating the position of the patient in their target pictures (left or right). However, in their exploratory analyses, the position of the patient was not a significant contributor to priming effects. Because the position of the patient did not contribute to answering their research questions, Sijyeniyo et al., chose to exclude this from their analysis. In this study, we do not include the position of the patient in our target pictures as a predictor in our regression models.

computer, and the participant did the same. Once the researcher and participant were both online on Microsoft Teams, the researcher sent the participant a link to the experiment. For the researcher to properly keep track of the course of the experiment, the researcher asked the participant to share their screen and asked them not to use headphones. Participants were not required to share their screen, but we stressed that it would aid the researcher and the flow of the experiment. The researcher only recorded participants' target audio responses to the prime sentences and did not make a videorecording of the session.

The experiment began with the practice block. Participants were instructed to provide a spoken description for the practice pictures using the verb placed at the bottom of each picture. Once participants had verbally described a picture, they pressed the spacebar to continue to the next one.

The 24 practice items were followed by the experimental block. Analogous to Sijyeniyo et al. (Chapter 4), the sequence of events during the experimental block went as follows: participants first heard a sentence, which was accompanied by an icon of an ear to clarify that they had to listen to an audio recording. After listening to the sentence, the participant pressed the spacebar and a verification picture appeared on their screen. Participants pressed [1] if the image matched the sentence they had just heard or [2] if the image did not match the description. The audio prime sentence and the verification image either matched perfectly or the image depicted something completely different from what they had heard. We did this so that the verification task was unambiguous.

After participants had provided an answer to the verification task, the target image appeared on their screen. The target picture was accompanied with a speaking symbol to indicate that participants had to verbally describe the target picture. To formulate a target response, participants were told to conjugate the Dutch verb that was displayed at the bottom of the target picture. If any of the objects or persons in the target picture were framed in red, participants had to start their response with this object or person. This applied to the target pictures that could be described with a transitive verb since more than one object is necessary to depict a transitive action. For the critical target sentences, participants were forced to use a passive sentence because the patient was framed in red. The passive sentence could either be a PP-final or PP-medial structure. After producing the target sentence, participants pressed the spacebar after which they heard the next audio prime sentence. This procedure was maintained throughout the experimental block.

Next, participants completed the Dutch LexTALE language test (Lemhöfer & Broersma, 2012). During the LexTALE language test, participants decided whether the word on their screen was an existing Dutch word or not. If, according to them, the word existed, they were asked to press 1. If the word did not exist, they were asked to press 2. After the LexTALE, participants had to complete the LEAP-Q questionnaire. Lastly, we asked participants to rate how correct the three passive forms (PP-final, PP-medial, and PP-initial passives) were based on a 7-point Likert scale. Sessions lasted about 60 minutes and participants were debriefed about the goal of the study via e-mail. *2.4. Coding*

The responses were manually coded as active sentences, PP-final passives, PP-medial passives, and “Other” responses. Active sentences were only coded as valid responses in the pre-experimental block. A response was coded as an active structure if the agent of the transitive event was mentioned first followed by the verb and the patient. Active sentences were coded as incorrect responses during the experimental block (and were thus deleted from the dataset), because we were only interested in passive responses during this block. PP-final passive responses were coded when the patient was mentioned first and if the sentence ended with a prepositional by-phrase using the preposition *door* (*by*). PP-medial passives were coded when the patient was mentioned first, and the prepositional by-phrase occurred in the sentence medial position and if the sentence ended with the past participle. “Short passives”, in which the agent is not overtly realized (e.g., *de bokser wordt achtervolgd* [the boxer is being followed]) were coded as "Other" responses. Lastly, sentences such as *De non wordt/is opgetild* ***bij*** *de piraat* - "*The nun is being lifted at the pirate" were also categorized as "Other" because the overt passive marker *door* (by) was not produced.

2.5 Analysis

We descriptively examined the data from the pre-experimental block to determine participants' spontaneous production preference in the absence of a prime sentence. More importantly, to answer our research question, we conducted an analysis on the data for the experimental block in which we tested for an interaction between *Prime Condition* and *L2 Proficiency*. The L2 proficiency of the participants was approximated by the raw scores on the Dutch LexTALE language test. The scores were scaled and centered before we entered them in our analysis.

For the analysis of the experimental block, we fit generalized linear mixed-effects models as implemented in the *lme4* package (Bates et al., 2015), with a Bobyqa optimizer to increase convergence (Powell, 2009) in *R* (R Core Team, 2020, version 4.1.2.). The dependent variable *Response* (PP-final passive vs. PP-medial passive, with the PP-final passive as reference level) is binary. As proposed by Barr et al. (2013), we added random intercepts and random slopes for *participant* and *item*. The maximal random effects structure consisted of *Prime Condition* as a random slope within-*participant*, and *Prime Condition* and *L2 Proficiency* as random slopes within-*item*. We report the *beta* estimates and the R^2 values (estimated by the *report* package, version 0.5.1; Makowski et al., 2020) as these are measures of effect size (Lorah, 2018). We use an alpha level of .05 for interpreting statistical significance.

Our maximal model was simplified in a stepwise way due to convergence and singularity issues. We simplified the random effects structure by successively testing if the random slope terms could be omitted without decreasing the fit of the model. Significance of the random slopes was tested using likelihood ratio tests. We removed random slopes for *items* before removing any random slopes for *participants* (cf. Segaert et al., 2016). After simplifying the random effects structure, our model fully converged and did not show any singularity issues. Our final model consisted of an interaction between *Prime Condition* * *L2 Proficiency* and random intercepts for *participant* and *item*.

3. Results

Pre-experimental Block

The bilinguals produced 372 responses to the pictures in the pre-experimental block (in the absence of primes). Of these responses, 286 were actives (76.9%), 22 were PP-medial passives (5.91%), 18 were PP-final passives (4.84%), and the remaining 46 responses were "Others" (12.4%). In Sijyeniyo et al. (Chapter 4), the L2 learners produced 1,101 responses[9], 735 active responses (66.8%), 26 PP-medial passives (2.4%), 20 PP-final passives (1.8%), and 320 "Other" responses (29.1%). Analogous to Sijyeniyo et al., participants in this study produced mostly actives in the pre-experimental block. Additionally, in both studies, the difference between the proportion of PP-medial and PP-final passives is very small, however, PP-medial passives were preferred over PP-final passives during the description of the pictures in the pre-experimental block. We did not fit a statistical model on the responses because of the small number of passive responses.

[9] Note that the number of responses of the learners in Sijyeniyo et al. (Chapter 4) is higher than the number of responses in this study. Sijyeniyo et al. had 92 participants in their dataset, while we have 31 participants in the current study. The comparison of the descriptive values is thus not very informative due to the large difference in group size. However, we still include this information, as this provides a general idea about how similar the production patterns are between the two studies (i.e., more actives than passives, and PP-medials are preferred over PP-finals).

Experimental Block

During the experimental block, the learners produced 1,116 target responses to the prime sentences. There were 516 (46.2%) PP-final passives, 450 (40%) PP-medial passive responses, and 149 (of which 51 were active sentences) (13.4%) “Other” responses. There was only one trial in which a participant did not provide a response (0.08%). We deleted the “Other” responses and the missing trial from our dataset, and because of this, our final dataset consisted of 966 observations. In comparison to Sijyeniyo et al. (Chapter 4), it seems that the current experimental manipulation affected the production of PP-final passives, such that more PP-final than PP-medial passives were produced in the baseline condition (see the right bar plot of Figure 1).

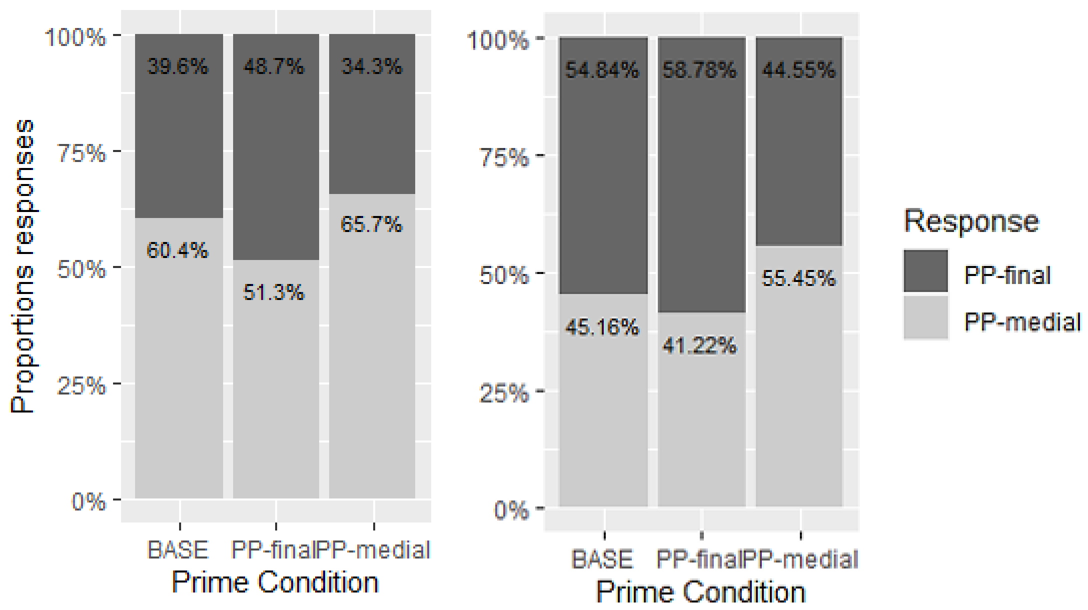

Figure 1 The proportion of PP-final and PP-medial passives per prime condition. The left bar plot depicts the proportions in Sijyeniyo et al. (Chapter 4) and the right bar plot depicts the proportions in the current study.

The final model’s (interaction between *Prime Condition* * L2 *Proficiency* and random intercepts for *participant* and *item*) intercept corresponds to the baseline condition and a

LexTALE score of zero (Table 2).

Table 2 Best Fit Model (N = 966; log-likelihood = -384.3)

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	-0.45	0.62	-0.72	0.470
Prime Condition PP-final	-0.56	0.28	-1.98	**0.047**
Prime Condition PP-medial	0.91	0.30	2.97	**0.003**
Dutch Proficiency	-0.99	0.60	-1.63	0.104
Prime Condition PP-final * Dutch Proficiency	0.56	0.27	1.99	**0.046**
Prime Condition PP-medial * Dutch Proficiency	0.40	0.28	1.44	0.151

Note. Final model = glmer(target response ~ Prime Condition*Dutch Proficiency + (1|Participant) + (1|Item), data = bilinguals, family = binomial)

In the baseline condition (at a LexTALE score of zero), the learners produced more PP-final passives than PP-medial passives, but this difference was not significant (b = -0.45, 95% CI [-1.67, 0.77], p = .470) (see also right bar plot in Figure 1: the proportion of PP-final and PP-medial passives in the baseline condition do not differ much from each other, compared to Sijyeniyo et al. [Chapter 4], which is depicted in the left bar plot). The bilinguals showed significant PP-final priming of 3.94% (b = -0.56, 95% CI [-1.12, 0.00], p =.047): they produced significantly more PP-final passives after a PP-final passive prime than after a baseline condition. The learners also showed significant priming for PP-medial passives (an effect of 10.29%) (b = 0.91, 95% CI [0.31, 1.51], p =.003). The effect of *Dutch Proficiency* in the baseline condition was not significant (b = -0.99, 95% CI [-2.19, 0.20], p = .104). This may have been due to low statistical power. Though the effect of L2 proficiency is not significant, the negative estimate indicates an increase in the proportion of PP-final passives in the baseline condition as the proficiency increases too. There was no significant interaction between PP-medial priming and L2 proficiency (b = 0.40, 95% CI [-0.15, 0.95], p = .151). In line with our expectations, we found that PP-final priming became significantly *smaller* upon increasing L2 proficiency (because the proportion of PP-final passives increased in the baseline condition) (b = 0.56, 95% CI [0.00, 1.10], p = .047) (see Figure 2 below).

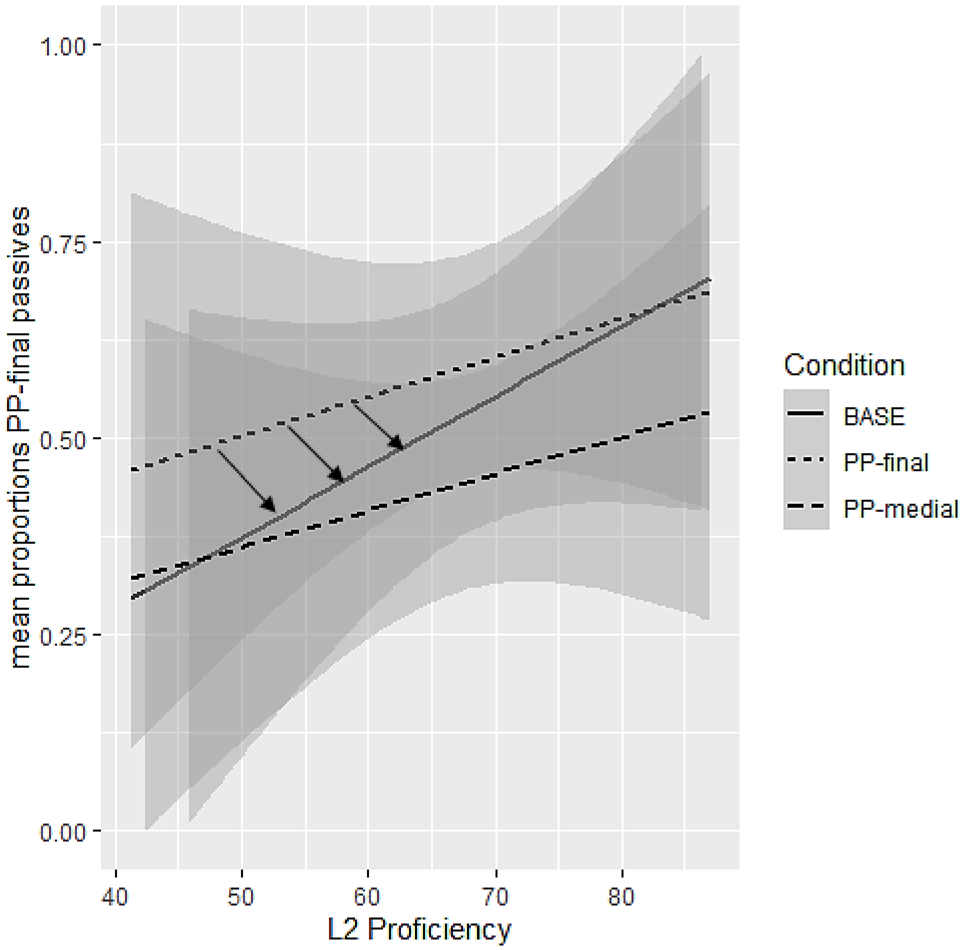

Figure 2 The interaction between PP-final priming and L2 proficiency. The y-axis represents the PP-final passive proportion, and the x-axis represents the L2 proficiency scores. The three separate lines represent the prime conditions. The difference between the proportion of PP-final passives in the PP-final passive prime condition and the baseline condition becomes smaller upon increasing L2 proficiency, causing a decline in the PP-final passive priming

effect (see arrows).

Given the *beta* estimates of the final model, all effect sizes reported above were small (Chen et al., 2010). The random effects part of the final model explains 76% of the variance (conditional R^2 = .76, substantial effect; Cohen, 1988) and the fixed effects part explains 6% of the variance (marginal R^2 = 0.06, small effect; Cohen, 1988).

Ratings of the PP-Final and PP-Medial Passive Structure

Given that our results and the results of Sijyeniyo et al. (Chapter 4) suggest that advanced bilinguals are more likely to produce PP-final passives than PP-medial passives in the baseline condition, there is a possibility that this may relate to how they rate both passive structures. If this were true, one might predict that learners (probably the more advanced bilinguals) who provide higher ratings for the PP-final passive also show stronger PP-medial priming. To test this, we conducted an additional analysis in which we explored whether there was a correlation between the ratings for PP-final passives and structural PP-medial priming across participants. Specifically, we expected PP-medial priming to become stronger upon an increasing PP-final passive rating.

We first investigated whether there was a correlation between PP-final rating (a continuous variable based on scores from the 7-point Likert scale) and L2 proficiency. We found no significant correlation between the ratings for PP-final passives and L2 proficiency $r(29) = -0.16$, $p = .366$). Thus, more advanced bilinguals did not provide higher ratings for PP-final passives (from Table 1, it is noticeable that the difference in the rating scores for PP-medial and PP-final passives was quite small, indicating that these two passive forms were probably considered correct by most learners).

Next, we explored whether there was a relationship between the ratings for PP-final passives and PP-medial priming. We found a significant positive moderate correlation between the rating for PP-final passives and PP-medial passive priming $r(29) = 0.38$, $p = .032$). As depicted in Figure 3, if participants provided a higher rating for PP-final passives, they also produced more PP-final passives in the baseline condition, and this correlation was significant ($r(29) = 0.39$, $p = .026$)). Because of this, this allowed a greater window for stronger PP-medial priming to occur (this is illustrated in Figure 3 by the black arrows).

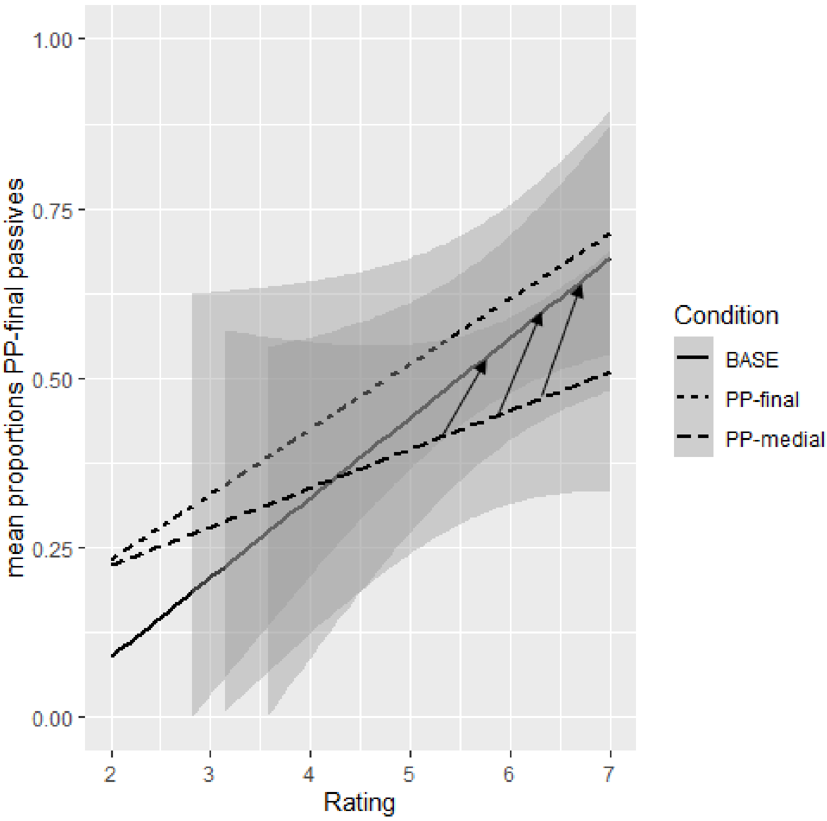

Figure 3 The positive correlation between PP-final passive rating and PP-medial priming. The ratings range from very bad, corresponding to a score of 2, to very good, corresponding to a score of 7.

4. Discussion

In this study, we asked whether explicitly learned L2 production preferences (see Sijyeniyo et al., Chapter 4) could change if learners receive an increased input of the less preferred L2 syntactic structure in the primes. Specifically, in our experiment, we increased the proportion of PP-final primes to 50% compared to the PP-medial passives, which remained at 33.33% of the primes (see Sijyeniyo et al., Chapter 4). Due to our manipulation, we observed a higher proportion of PP-final passive sentences in our baseline condition, compared to Sijyeniyo et al. Based on the predictions of the implicit learning account, we anticipated stronger PP-medial priming than PP-final priming in the late learners of Dutch. We found priming for both passive forms, but PP-medial priming was stronger than PP-final priming, which is line with the inverse-frequency effect (Jaeger & Snider, 2013; Hartsuiker & Westenberg, 2000). Sijyeniyo et al. found stronger PP-final priming than PP-medial priming. Analogous to Sijyeniyo et al., we predicted an L2 proficiency effect in our baseline condition: we assumed that advanced learners of Dutch would produce more PP-final passives than PP-medial passives in the baseline condition, and therefore, they would show stronger PP-medial priming than less advanced bilinguals. We found that PP-final priming became significantly *smaller* upon increasing L2 proficiency. Interestingly, the significant interaction between L2 proficiency and PP-final priming in this study complements the significant interaction between L2 proficiency and PP-medial priming observed in Sijyeniyo et al.: we found that PP-final passive priming became significantly *smaller* upon increasing proficiency, while Sijyeniyo et al. found that PP-medial priming became significantly *stronger* upon increasing proficiency. The explanation that holds for both effects is that higher proficiency bilinguals produced more PP-final passives than PP-medial passives in the baseline condition, and this created room for stronger PP-medial priming to occur, while the window for PP-final priming became smaller upon increasing proficiency. It seems that the strength of PP-final and PP-medial priming in learners of Dutch with L1 French is determined by the level of L2 proficiency of these learners.

Given the predictions of the implicit learning account (Chang et al., 2006), it seems relevant to compare our results to those in Segaert et al. (2011), Sijyeniyo et al. (Chapter 4), and Kaschak (et al., 2006; 2007). Our results and the results of Segaert et al. can be explained by the implicit learning account. Due to increased exposure to the less preferred PP-final passive structure in this study, the representation of the PP-final passive was strengthened in the memory of the learners, such that the odds to generate the same construction in the target trials increased. This became clear in the baseline condition. Also, because PP-final passives were offered more frequently in the primes, we observed stronger PP-medial priming than PP-final priming, which coincides with the inverse-frequency effect. The results of Segaert et al. are somewhat similar to our results, in the sense that the experimental group produced more passives in the baseline condition due to the increased proportion of the same structure in the training session, compared to the control group. However, whereas we obtained a completely flipped distribution of the passive alternants in the baseline condition, in favor of the PP-final passive structure, actives remained the preferred transitive alternant in the study of Segaert et al. This might be because of the high frequency of usage of actives amongst speakers, which is almost at ceiling. Obtaining a flipped frequency distribution in favor of passives would have been less likely to occur in the study of Segaert et al. Interestingly, in terms of priming for the less and more frequent alternative, Segaert et al. report a similar priming pattern to ours: passives were offered more frequently in the training session of the experimental group, and therefore, they observed stronger abstract active priming than abstract passive priming in this group, compared to the control group. In contrast, lexically-based active and passive priming were equally strong in the experimental group. This suggests that the increased proportion of passives in the training session of the experimental group may have only affected abstract syntactic processes during the structural priming experiment. A few implications arise from our study and parts of the results in Segaert et al.: (1) Preference ratios are *dynamic*, as they seem to be influenced by learning, and therefore, they can shift within just one experiment. However, the extent to how dynamic preference ratios are, may vary across different syntactic alternants. In other words, a completely flipped preference ratio is more likely to occur within PP-final and PP-medial passives than within actives vs. passives. (2) Explicitly taught L2 biases may easily shift, whereas this may not be the case for implicitly learned biases in the L1 (see Segaert et al.). This is because L1 syntactic representations are more deeply rooted in memory compared to L2 syntactic representations. As a result, infrequent sentence structures, such as L2 syntactic structures (compared to L1 syntactic structures), lead to more significant changes in biases. Note that, according to the implicit learning account, changes to the weights of a structure becomes smaller as it is encountered more frequently. (3) We only tested abstract structural priming, but from the results of Segaert et al., who tested abstract and lexically-based structural priming, it seems that changes in the frequency distribution of two syntactic alternants only affect *abstract* structural priming.

The results of Kaschak’s work (et al., 2006; 2007) are somewhat comparable to ours in the sense that repeated exposure to one syntactic alternant (POs) in prime sentences increased the proportion of this structure in the target completions, relative to the rate at which the same structure was produced in the norming study (which functioned as a baseline). Interestingly, Kaschak did not report stronger priming for the construction that was offered less frequently during the experiment, which does not corroborate the inverse-frequency effect. A possible reason for their finding may lay in that Kaschak always used lexical overlap between prime and target sentences. The implicit learning account does not predict an influence of lexical repetition on structural priming effects, and for this reason, one would still expect to find stronger priming for the alternant that is offered less frequently in an experiment. However, the results of Kaschak suggest that the processing of primes and targets that have lexical overlap may depend on a different mechanism. Namely, the explicit memory of the prime structure may function as a cue for retrieval from working memory, as proposed by Bernolet et al. (2016). Bernolet and colleagues suggest that when prime and target sentences immediately follow each other, production preferences are influenced by the explicit memory of the recently processed prime sentence. Any similarity between the prime sentence and the target trial (e.g., on the lexical level) can serve as a retrieval cue to the explicit memory. This then increases the odds for repeating the syntactic structure of the prime structure for the formulation of the target sentence. This may explain why Kaschak found *stronger* priming for the dative alternant that was offered more frequently in his experiment, and why he found *weaker* priming for the alternant that was offered less frequently in his experiment. Put differently, the lexical overlap between prime and target trials might have functioned as a retrieval cue to the explicit memory of the structure that was offered more frequently during Kaschak’s experiments, inciting stronger priming for this structure and weaker priming for the alternative structure.

We would like to address why we believe the residual activation account as proposed by Pickering and Branigan (1998) cannot explain the results of our study. According to the account, the mechanism that is responsible for structural priming effects is active for only a short period (i.e., when the target does not immediately follow the prime, the activation diminishes). Therefore, we believe that it is unlikely that this mechanism can keep track of the frequencies with which syntactic alternants have been previously experienced by speakers over a longer period (e.g., from the beginning until the end of an experiment). There are models that have extended the activation-based account as proposed by Pickering and Branigan, such that the mechanism can “learn”, which leads to long-term adaptations in the weights given to a structure, like the mechanism proposed in the implicit learning account (Chang et al., 2006). For instance, Reitter et al. (2011) integrate aspects of the residual activation account and the implicit learning account in their hybrid model for L1 structural priming. In brief, they suggest that activation of lexical and syntactic information is determined by two important mechanisms, the *base-level activation* of syntactic information and *spreading activation* from lexical information to syntactic information. Due to implicit learning processes, high frequent structures have a higher base-level activation than structures that occur less frequently. Because of this higher base-level activation, less learning occurs for higher frequency structures. As such, stronger priming will occur for less frequent syntactic structures (because more learning takes place) than for more frequent ones, similar to the predictions of the implicit learning account (Chang et al., 2006). The second aspect of their model suggests that structural priming is a result of lexical activation that spreads from working memory to longer-term memory. That is, during production, the lexical information that is represented in working memory acts as a cue to retrieve syntactic information, which explains enhancements of structural priming, such as the lexical boost effect (Pickering & Branigan, 1998). Reitter et al. propose that the lexical boost effect should not be restricted only to the repetition of lexical heads such as Pickering and Branigan. Rather, according to Reitter et al., any form of lexical overlap between the prime and the target should enhance priming. Thus, the hybrid model combines aspects of lexicalist accounts (spreading activation) and implicit learning accounts (base-level activation) that can explain different structural priming effects. However, it is not yet clear how such a hybrid model may explain structural priming in bilinguals.

Lastly, based on our results, we predicted that a higher rating for PP-final passives may entail stronger PP-medial priming (or smaller PP-final priming). We found a significant positive correlation between PP-final rating and PP-medial priming: participants who provided higher ratings for PP-final passives showed stronger PP-medial priming. However, it was not the case that these were only higher proficiency bilinguals, as there was no correlation between L2 proficiency and PP-final passive rating. Though these rating-results should be further explored (the scores of the ratings might have been influenced by our priming manipulation, for example), we propose that future studies could include ratings of syntactic alternants in structural priming studies that concern late learners. Specifically, in situations where learners' experiences towards one of the syntactic alternants have been shaped due to explicit teaching, our results cautiously indicate that there may be a relationship between how correct structural alternants are perceived and the direction and strength of the priming effect(s).

5. Limitations and Future Directions

A practical limitation of this study is that we did not use the same number of participants as Sijyeniyo et al. (Chapter 4). Sijyeniyo and her colleagues recruited 96 French-Dutch bilinguals for their study. However, the researchers recruited their bilinguals in two different locations in Wallonia (Belgium): 48 participants were recruited in Brussels and another 48 in Louvain-la-Neuve. It is important to note that the initial recruitment of French-Dutch bilinguals in different locations was based on research questions that were not pursued in the final article. Nevertheless, we deem it important to address the difference in the number of participants in the current study and the number of participants in Sijyeniyo et al., as this might raise some questions. Despite the obvious difference in participants between both studies, this study found priming effects that support and complement the results of Sijyeniyo et al. It seems that the effect of our manipulation was strong enough such that not as many participants as in Sijyeniyo et al. were required for the priming effects to occur.

Another difference between this study and Sijyeniyo et al. (Chapter 4) is that we collected our data through online testing, whereas Sijyeniyo et al. tested their participants in a lab. However, this study still occurred in a controlled context because the researcher was always present during the online experiment. Our testing method may open new avenues for setting up structural priming experiments online, especially because researchers are increasingly using online methods to collect their data (see e.g., Slim & Hartsuiker, 2022, who used webcams to test whether the visual world paradigm can be moved online).

Even though the proportion of PP-final passives in the baseline condition of the current study was higher than the proportion of PP-final passives in the baseline of Sijyeniyo et al. (Chapter 4), it could be that the effect of this boost diminished as soon as participants had completed our experiment. Ideally, it would have been interesting to subject the same participants to a post-experimental block (using 24 items, like in the pre-experimental block) in which they were asked to describe pictures in the absence of a prime sentence. If the effect of frequency manipulation would be robust enough, we would have perhaps observed more PP-final passives in participants' target production compared to the proportion of PP-final passives in the pre-experimental block. If future studies were to replicate our study, we suggest that such a post-experimental block should be included, as it provides better insights as to whether a short-term increase of less preferred L2 syntactic structures within an experiment affects long-term structural choices of L2 learners. Future studies could also use verb overlap in their prime sentences to boost the learning of less preferred L2 syntactic structures even more, as the lexical boost has been found to increase the production of less preferred L2 structures too (Van Lieburg et al., Chapter 2).

Our study concerned structural priming in an experimental context, but we encourage future studies to investigate our intervention method in an ecologically valid learning context, such as in an L2 classroom, specifically when L2 syntactic learning concerns the acquisition of less preferred or infrequent L2 syntactic alternants. This study could add to and extend the work on using structural priming for teaching purposes (see e.g., work by McDonough, 2006; McDonough & Mackey, 2008; Kim & McDonough, 2016).

6. Conclusion

In this study, we found that structural priming can be used as an intervention method to boost the production of a less preferred L2 syntactic structure (PP-final passive structure) in the baseline condition compared to the preferred PP-medial passive structure in learners of Dutch with L1 French. We increased PP-final passive in our primes to 50%, and this strengthened the syntactic representation of this structure such that it became easier to produce the same structure in the target trials, compared to the explicitly taught PP-medial passive structure. As PP-final passives were offered more frequently in the primes, we observed stronger PP-medial priming than PP-final priming. These results are in line with the predictions of the implicit learning account (Chang et al., 2006). Moreover, we observed that L2 proficiency is an important predictor for the strength of PP-final and PP-medial priming amongst learners of Dutch with L1 French, a result that complements the findings in Sijyeniyo et al. (Chapter 4).

Finally, our priming method may inspire language researchers, who aim to investigate how dissimilar and perhaps less frequent L2 syntactic structure may be learned more efficiently by increasing exposure to the less preferred structure compared to the preferred alternative. Thus, our hope is that our priming method will be useful to language teachers, who may want to apply our method during their L2 classes.

CHAPTER 6

DUTCH NORMING STUDY FOR 208 COLOR DRAWINGS DEPICTING TRANSITIVE EVENTS

All data, analysis code, and experimental lists are available at
https://tinyurl.com/DutchNormingStudy

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Abstract

We conducted a norming study amongst Dutch children (6-12 years) to investigate whether they would correctly interpret our set of 208 color drawings, developed for longitudinal research on the production and comprehension of transitive sentences, if the transitive action on each drawing was described with an active or a passive sentence.

The children provided 93.02% correct answers to our pictures, which indicates that the pictures are clear in terms of how the transitive actions are displayed. There were several factors that contributed to an incorrect interpretation of a transitive action in a picture. (1) Pictures were more difficult to interpret when a passive sentence was used to describe a transitive event compared to an active sentence; (2) children made more errors interpreting pictures when abstract verbs, such as “inhalen” (to overtake) and “vervangen” (to replace), were used to describe a transitive event; (3) children had difficulty interpreting our pictures when particular verbs (“roepen” [to shout] and “volgen” [to follow]) were presented in a passive sentence, while other verbs (“blokkeren” [to block] and “inhalen”) rendered more *correct* answers when the transitive event was described with a passive sentence; finally, (4) younger children provided more incorrect answers to our pictures than older children, regardless of whether the transitive action in the picture was described with an active or a passive sentence. In particular, the younger children provided significantly more incorrect answers to pictures with the verb ‘groeten” (to greet) compared to the older children.

Because our set contains many verb-noun combinations, the set is very useful to researchers who intend to investigate the acquisition of transitive structures in children in a longitudinal design, not only for studies with typically developing children, but also in studies with children who have a delay in their language development.

Keywords: Norming study, picture set, transitive structures, L1 syntax acquisition

1. Introduction

A crucial step in carrying out meaningful experiments is to choose appropriate stimuli. For instance, researchers in psychology and psycholinguistics often use pictures as stimuli in their experiments to investigate different aspects of language such as sentence production and comprehension. These pictures need to be explicit and clear enough so that they elicit specific syntactic structures from language users. A research domain in which pictures are often used to investigate the production and comprehension of syntax is the field of structural priming (Bock, 1986). Structural priming is the tendency of speakers to repeat structures that they have been recently exposed to; this is often investigated with picture descriptions or sentence completions (Mahowald et al., 2016). Most structural priming studies use pictures where transitive or ditransitive actions are displayed, and, often, these studies have used just two picture sets: the set by Bock (1986) and the one by Branigan et al. (2000). These sets have in common that they consist of black-and-white line drawings with combinations of animate and inanimate nouns performing or undergoing an action, and that they have been mostly used in studies with native speakers or highly proficient second language (L2) speakers (see e.g., Bernolet et al., 2009; Favier et al., 2019). A difference between both sets is that the pictures[1] in Bock are rather outdated and may not necessarily appeal to, for instance, children, whereas the picture set of Branigan et al. seems more suitable to use in studies that investigate language production in special populations. However, both picture sets include verbs and nouns that are somewhat *infrequent*[2] and may be familiar to native language users or highly proficient L2 speakers, but not to other groups such as late L2 learners or children. Some

[1] See OSF directory (https://tinyurl.com/DutchNormingStudy) for an example of pictures from both picture sets.
[2] In this paper, we denote frequent words based on Zipf-frequencies (Van Heuven et al., 2014; Keuleers et al., 2010). Zipf-frequencies range from 1 to 7, the values 1-3 indicate low frequent words (i.e., frequencies of 1 per million words and lower) and the values 4-7 indicate high frequent words (i.e., words with frequencies of 10 per million words or higher).

infrequent verbs and nouns in Branigan et al. include, for instance, "to polish"[3], "to scold"[4], and "a monk"[5]. This important characteristic impedes researchers to confidently use the two picture sets when testing non-native or young language users.

Using frequent verbs (and nouns) in stimuli is especially important in studies involving children. This is because several studies have suggested that children are sensitive to lexical frequency information (Theakston et al., 2004); and that this frequency effect on the acquisition of lexical items is crucial in their development of syntactic knowledge (Matthews et al., 2005; see Ambridge et al., 2015 for an extensive review). If young children are exposed to an infrequent, and perhaps unfamiliar, lexical item and are asked to formulate a syntactic structure with that verb, they might have difficulty formulating the elicited syntactic structure since lexical representations play a role during the selection of syntactic structures (Ambridge et al., 2015; Pickering & Branigan, 1998). This highlights the importance of using frequent lexical items in stimuli that are aimed at investigating the production of syntax in young L1 users (but also in late L2 learners).

To keep the attention span of children to the task, many studies involving children use color drawings in their stimuli (see e.g., Huttenlocher et al., 2003; Goldwater et al., 2011). However, it is noticeable that the number of items in these studies is often limited. For instance, Huttenlocher et al. used 40 color drawings as their stimuli to investigate the priming of transitive and dative structures in children (two sets of 20 drawings for each structure). Moreover, Goldwater et al. used nine critical items (color drawings) in their structural priming experiment with 4- and 5-years old. Using a limited number of items usually requires more participants in the test sample to reach sufficient statistical power for observing priming effects (see Mahowald et al., 2016). It seems that, ideally, in studies with less experienced

[3] "To polish" has a Zipf-frequency of 3.03
[4] "To scold" has a Zipf-frequency of 3.12
[5] "monk" has a Zipf-frequency of 3.86

language users (i.e., children and late L2 speakers), there should be a balance between sufficient experimental items that use frequent verbs and enough participants.

Note that Muylle et al. (2020c) designed a stimulus set of 423 animated movie clips depicting transitive and dative actions (prepositional object datives ["The woman gives a flower to the man"] vs. direct object datives ["The woman gives the man a flower"]) that can be used to investigate transitive and ditransitive comprehension and production in groups such as adult L2 learners or children. Indeed, as the researchers propose, using clips that depict motion events may be easier for non-native or young language users since the action does not have to be inferred. Therefore, motion clips may be more ecologically valid than static pictures. However, some movie clips in Muylle et al. are rather violent (e.g., "A boxer punches a dancer"). Because of this, some of their clips may still not be very appropriate to use in studies with children.

In addition to animated movie clips, some studies have used live action objects, such as bunnies and ducks (Gertner et al., 2006) to elicit syntactic structures from young children in a language production task. Though these types of stimuli may strongly appeal to children, the development of such stimuli is effortful and can often only be used for the aforementioned group and not for other groups of language users (e.g., late L2 learners, people with aphasia…).

Here, we propose a set of colored pictures that was initially designed to test transitive comprehension and production in adult learners of Dutch. However, the purpose of the current study is to investigate whether our picture set is suitable to use in studies with young children too. For this reason, we conducted a norming study amongst young monolingual Dutch children.

Current study

In this study, we used 208 color drawings that were initially developed for longitudinal research on the production and comprehension of transitive sentences in adult learners of Dutch. Prior to constructing the color drawings for the late learners, we consulted their language learning materials to make sure that we used familiar verbs and nouns in our stimuli set[6]. Based on the learning materials, we chose transitive verbs (e.g., to call, to carry, to follow…), names of human professions (e.g., a cook, a baker, a teacher…), and names of vehicles (e.g., a car, a truck, a motorbike…) (see Appendix S7 for the verbs and nouns). We used a restricted number of verbs (12 verbs) and nouns (8 animate nouns and 8 inanimate nouns) for the color drawings since we wanted to avoid that the learners would be exposed to many different words. However, despite the small number of verbs and nouns that we used, our picture set was designed such that different verb-noun combinations are possible, which allows the same verb to be presented with different nouns while avoiding lexical overlap between items. This makes our picture set particularly suitable for longitudinal designs, since researchers can, for instance, test the acquisition of specific transitive verbs and both transitive structures (active and passive sentences) in adult and young language users, while avoiding a learning effect caused by repetition of the pictures.

A previous study showed that our picture set is indeed suitable to test the production of transitive structures in a group of late learners of Dutch. In a structural priming experiment, Van Lieburg et al. (Chapter 2) observed that the learners produced 49.5% active sentence responses, 29.9% passive sentence responses and 20.7% “Other” responses to the transitive pictures. This suggests that the transitive events in our drawings largely elicit active as well as passive responses.

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[6] To our knowledge, there exist no frequency data bases on the acquisition of Dutch verbs in late adult learners. For this reason, using the learners’ learning materials was reliable for our study as it ensured us that we were using familiar words to these learners.

In the current study, however, we investigated whether the same picture set is suitable to use in studies involving young children. For this purpose, monolingual Dutch children (a group of 6-7 years old and a group of 11-12 years old) indicated whether our drawings can be interpreted equally well with an active and a passive sentence. We predict that these children will have difficulty interpreting our pictures when a transitive event is described with a passive sentence, since passives are complex structures and are learned relatively late (around the age of 3) compared to active sentences (Messenger & Fisher, 2018; Verrips, 1996). Passives are particularly complex to acquire by children due to their noncanonical word order. Namely, in passives, the agent of the sentence does not occur in the grammatical subject position compared to conventional word order rules, particularly in SVO languages. Moreover, language production studies have suggested that children are more likely to first produce short passives (passive structures in which the by-phrase is not overtly realized: "The bear is hugged") than full passives (Fox & Grodzinsky, 1998). However, language comprehension studies have not found a consensus as to whether short passives are comprehended earlier than full passives (Hirsch & Wexler, 2006). Although young children can produce passive sentences spontaneously by the age of 3, they seem to have persistent trouble with understanding some type of passives. A common difficulty in young children's understanding of passives are reversed passives (Messenger et al., 2012; Armon-Lotem et al., 2016). Reversed passives are passives in which full grammatical knowledge is required for the child to interpret who does what to whom (Armon-Lotem et al., 2016). For instance, in the sentence "The woman was kissed by the man", the animate noun in the grammatical subject position and the one in the by-phrase can be exchanged since both nouns can do the kissing. Thus, here, the grammatical subject can be replaced with the agent in the by-phrase, while the sentence remains grammatically correct. If a child would be asked who does the kissing, they would most likely answer that the woman is the one doing the kissing (based on conventional word order rules). Nonreversible passives, however, are less challenging for young children to understand since children can rely on world knowledge to interpret who does what to whom (e.g., “The cheese was eaten by the mouse”) (Armon-Lotem et al., 2016). Here, the child knows that only the mouse can do the act of ‘eating’. Next to this, children have difficulty understanding passives with mental state verbs (e.g., *remembered, forget, know, believe – “*Joanna was forgotten by Olivia”). This type of passives is challenging for young children because the agent is experiencing the mental state (here, Olivia is doing the forgetting), while nothing “happens” to the patient. In contrast, passive sentences with actional verbs (e.g., *to push, to hug, to carry…*) are less challenging for children since the transitive action is carried out by the agent, while the patient undergoes the transitive action (Armon-Lotem et al., 2016). These features of the passive structure explain why the production and comprehension of (full) passives remain challenging throughout the first years of a child’s education (Messenger et al., 2012).

Next to the difficulty in passive sentence comprehension, we also investigated to what extent the transitive verbs on our pictures would affect the children’s comprehension of each transitive action, when an active or a passive was used to describe this action. We focused on verbs specifically (and not on the nouns in our pictures) because verbs are the most important building block in constructing syntactic structures (see Ambridge et al., 2015). Before conducting our experiment, we did not test whether the children knew the verbs that we used on our pictures, but we assumed that some of our pictures contain verbs that are abstract and may not have been acquired yet by the children. For example, one of our pictures depicts an event in which a car overtakes a truck (“*De auto haalt de vrachtwagen in*” – “The car overtakes the truck”), and the picture has been drawn from a bird’s eye view (see Figure 1). Because adult learners have experience in traffic, understanding who passes whom is not particularly difficult. However, “inhalen” may be a challenging word for children because they do not have that same experience yet, especially because the action verb has been drawn from a bird's eye view[7]. What is more, young children might also have not acquired this verb yet ("inhalen" is acquired around the age of 8;61 years by Dutch children, see Brysbaert et al., 2014). In addition to this, "inhalen" has a Zipf-frequency of 2.72 (Keuleers et al., 2010); this means that it is considered a low frequent word[8], which may cause even more difficulty for children to interpret pictures with this verb correctly. Moreover, we expect that the combination of some abstract verbs (such as "inhalen") with a passive voice will further restrict the children's comprehension of the transitive event in our pictures.

Finally, we anticipate that, in general, the older children will be better at interpreting our pictures, either described with an active or a passive sentence, compared to the younger children. If this turns out to be the case, then our picture set will be suitable to test how children make progress in the comprehension of transitive structures.

2. Method

2.1. Participants

Two hundred participants, 86 in the first grade (41 males and 45 females) and 114 in the fifth and sixth grade (56 males and 58 females), took part in this study. Participants in the first grade were 6-7 years old and participants in the higher grades were 11 or 12 years old. Five classes in the first grade participated and five classes in the higher grades took part in this study (two classes in the fifth grade and three classes in the sixth grade). The participants were recruited at the same primary school in Antwerp, Belgium. All parents provided their

[7] Of course, if "inhalen" depicted a transitive event that is more familiar to children (a bike race or a running contest) or if pictures with this verb were drawn from a side view, the verb may be easier for children to comprehend. However, here, we specifically predict that the combination of the abstract verb "inhalen" together with the bird's eye view will probably require the children to make more inferences, which will probably lead to difficulty in comprehension.
[8] It is important to note that the verb Zipf-frequencies in Keuleers et al. (2010) are based on Dutch film subtitles.

consent for their child's participation in this study. The classes received a monetary reward for their participation. This study was approved by the ethical committee of the University of Antwerp (SHW_1877).

2.2. Stimuli and Design

Stimuli

We used 208[9] pictures for the present study. The 208 pictures were pairs of target and competitor pictures (thus, there were 104 pairs). We used 12 different verbs to depict transitive events in the set of 208 pictures. The target and competitor pictures always used the same verb. The verbs were more or less equally divided across the 208 pictures: four verbs (*aanrijden* [to hit], *bellen* [to call], *dragen* [to carry], and *volgen* [to follow]) each occurred 20 times in the set and eight other verbs (see Appendix S7 for all the verbs; their Zipf-frequency and the age of acquisition of these verbs) occurred 16 times in the pictures. Importantly, because we used the verbs based on the L2 learning materials of late Dutch learners (see above), we did not control for how many verbs were abstract or concrete (i.e., we did not equally divide the verbs into an abstract and concrete category). We believe that our materials consist of 3 abstract verbs (inhalen [to overtake], vervangen [to replace]; blokkeren [to block]), while the remaining 9 verbs may be considered concrete verbs (see Appendix S8 for examples of pictures with the abstract verbs "vervangen" and "blokkeren"; see Figure 1 for an example with the verb "inhalen"). Next to this, the agents and the patients of the transitive actions could be one of eight animate entities referring to a profession (e.g., a baker, a construction worker, a cook) or one of eight inanimate entities referring to a vehicle (e.g., an ambulance, a firetruck, a car [see Appendix S7 for all the nouns]). Thus, our

[9] There were 194 unique pictures, but 14 pictures were used twice and elicited two different states of affairs (e.g., the picture for an ambulance replacing a bus elicited the sentence "the ambulance replaces the bus" in one trial, while it elicited the sentence "the bus is being replaced by the ambulance" in another trial). The pictures that occurred twice in the set are marked in the OSF directory.

sentences contained only animate subject – animate object (e.g., “De bakker helpt de zangeres” – “The baker helps the singer”) or inanimate subject – inanimate object (“De vrachtwagen volgt de auto” – “The truck follows the car”) combinations. It is important to note that all sentences in our picture set were reversible (i.e., the agent and patient can be exchanged while our sentences remain grammatically correct) and that all our verbs were *actional* verbs (our materials did not have any mental state verbs).

Design

The target-competitor pairs were divided in five different lists consisting of 42 or 41 items. After doing this, we randomly assigned the five classes in the lower and higher grade to one of the five lists (these lists were later converted into separate booklets, see below). The first three lists had 42 target-competitor pairs and the last two lists consisted of 41 pairs. In every list, we manipulated the position of the target pictures within each target-competitor pair. This means that, within a list, half of the target pictures (21 or 20 pictures) appeared on the left and the accompanying competitor pictures appeared on the right (see Figure 1). Similarly, the other half of the target pictures (also 21 or 20 pictures) were on the right and the accompanying competitors were on the left. Next to this, we aimed to equally present an active and passive interpretation of a target picture within each target-competitor pair. For this reason, within a list, half of the sentences (i.e., the sentences that participants would hear during the experiment) were actives and the other half were passives. For example, if the children would be presented with an active sentence “The car overtakes the truck”, they would see two pictures (see Figure 1). In the correct target picture, the agent is the car, and the truck is the patient. In the competitor picture, the agent is the truck, and the patient is the car. The competitor picture could either be described with an active sentence “The truck overtakes the car” or with a passive sentence “The car is being overtaken by the truck”. We included the competitor picture to test whether the children would interpret the first noun phrase as an agent (active interpretation) or a patient (passive interpretation).

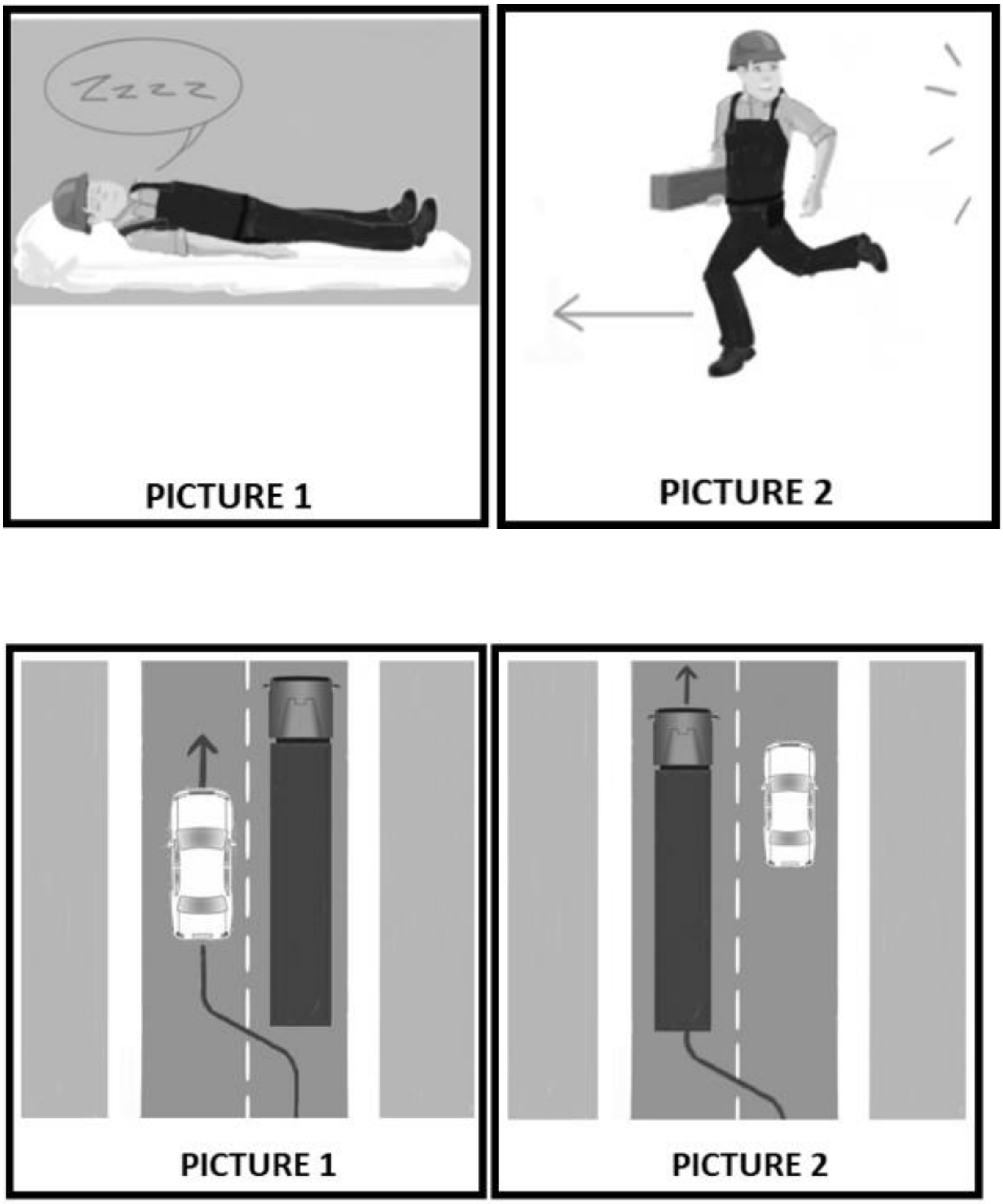

Figure 1 An example of a target-competitor pair in the practice trial for the sentence "*De bouwvakker slaapt*" – The construction man sleeps (1) and in an experimental trial (2) for the sentence "*De auto haalt de vrachtwagen in*" – The car overtakes the truck. For both trials, the

correct picture is on the left and the competitor picture is on the right. Note that the pictures are in black and white in this dissertation, but the original pictures are in color (see https://tinyurl.com/DutchNormingStudy).

Because each target-competitor item appeared once within a list, we could only present the active or passive interpretation of that target picture. Since our goal was to test the children's comprehension of a target picture in both transitive sentence structures, we manipulated the condition of each target picture across lists. That is, each target picture was presented with an active sentence in one list and with a passive sentence in another list. In this way, we collected data on whether children interpretated the target picture correctly when it was described with an active sentence and its passive counterpart. Furthermore, the target-competitor items were constructed such that each transitive verb occurred at least once in each list; thus, every participant was exposed to all twelve verbs.

Our list construction deviates from conventional experimental lists in psycholinguistics due to several reasons. (1) Because we tested young children, we could not expose them to all 104 target-competitor pair items due to their attention span and thus, we reduced the number of items that children were exposed to within a list (42 or 41 items). (2) Our aim was to test whether a target picture could be interpreted equally well with an active and passive sentence, and because of this, across lists, there were two conditions, but we had five experimental lists (the first 3 lists had 42 items, and the last two list had 41 items). For this reason, we selected a different set of items for each list.

2.3. Procedure

Because of the COVID-19 pandemic, the experiment could not be administered by the researchers themselves. For this reason, the children were tested in class and the experiment was administered by their teachers, whom we provided with detailed instructions. Each class was assigned a separate list (there were five lists in total). We presented the five lists with the target-competitor items in five separate Microsoft PowerPoint presentations. The teachers were also provided with a Word Document containing the pictures of the (in)animate nouns that would appear in the experiment. The teachers first showed this document on a digital white board to the children to familiarize them with the pictures of the nouns and their accompanying names. After this, the teachers could start with the experiment, which was presented in a PowerPoint Presentation on a digital white board. Each list (i.e., each presentation) started with the same practice trial consisting of an audio file of the intransitive sentence "*De bouwvakker slaapt*" – "The builder sleeps". We used an intransitive sentence in the practice trial so that the goal of the experiment (how children interpret transitive events when a passive or an active sentence is used) would not be revealed. After participants had listened to the audio file, the teacher showed the target and competitor pictures describing the intransitive event on a separate page on the PowerPoint presentation (see Figure 1). The two pictures were framed with a black line. The phrase "picture 1" appeared at the bottom of the left picture, and "picture 2" appeared at the bottom of the right picture (Calibri bold, 18-point font, see Figure 1). At this point, the teacher asked the class which picture depicted the sentence "*De bouwvakker slaapt*" and the children had to say the answer out loud. After the practice trial, teachers could start with the experimental trials. For each trial, the children listened to an audio file of a sentence describing either an active or passive transitive event. Subsequently, a picture of the target and competitor item, that depicted the transitive event, was shown on the PowerPoint-presentation. Crucially, the same target-competitor items that were shown in the PowerPoint presentation were also presented to each participant in their answer booklet. It is important to make clear that, unlike the practice trial that did not appear in participants' answer booklet, the experimental trials all appeared in the children's answer booklet. In each child's answer booklet, every target and competitor item appeared on one page next to each other (see Figure 1 for an example of the verb 'inhalen' – to overtake). The presentation of the target-competitor items in the PowerPoint presentation and in participants' answer booklet was done to enable group testing. Participants had to indicate which picture (either picture 1 or 2) matched the sentence they had heard; they marked this in their booklets.

We told teachers that each audio file could be listened to twice. Because we wanted to provide teachers with some flexibility in how they played the audio files to the children, teachers could either choose to let the children listen to an audio file the first time, after which they marked the picture in their booklet, and listened to the same audio file again, or teachers could let the children listen to each audio file twice before they provided an answer in their booklet. In this way, teachers could freely choose which method worked best for their class. We emphasized that once teachers had chosen a method, they had to stick to it throughout the experiment. We also provided teachers with an Excel sheet in which the audio sentences were written down. Teachers could consult the sheet in case they wanted to know which sentence the children would hear next. We instructed teachers to allow the children to ask questions during the experiment or to further explain what was expected from them. Also, we told teachers that if any technical difficulties would occur during the experiment (i.e., if an audio file could not be played), they were allowed to read the sentence out loud to the children; they could use the Excel sheet for this. Sessions took approximately 30 to 45 minutes.

2.4. Coding

The answers to the pictures were coded as correct or incorrect. If the target picture was marked, the trial was coded as correct and if the competitor was marked instead, the trial was coded as incorrect. Moreover, if it was clear that the pupils first gave one answer and then changed it (e.g., by erasing it), the first given answer was coded. We did this because, in this study, we were specifically focused on the children's initial comprehension of the sentence they had heard. We believe that including the self-corrected trials in the analyses would not provide us with the most accurate comprehension of a given picture. On trials where children did not provide an answer, the trial was marked as a missing value (i.e., NA). We did not include the missing values in our analyses reported below, since our dependent variable was a binary response, and the number of missing values was very low (see below).

2.5. Analysis

We fit the answers to the pictures (correct answer vs. incorrect answer, correct answer as the reference level) to generalized linear mixed effect models as implemented in the *lme4* package (Bates et al., 2015) in *R* (R Core Team, 2020). Our full model consisted of a three-way interaction between *Condition* (active, passive, active as reference level) * *Verb* (aanrijden [to hit] as reference level) * *Grade* (high grade vs. low grade, high grade as reference level); we used a Bobyqa optimizer to increase convergence (Powell, 2009). We accounted for the non-independence between observations from the same participant and from the same item by entering the random intercepts for *participant* and *item*. Following the maximal random effects structure as proposed by Barr et al., (2013), we added *Condition* and *Verb* as random slopes over *participant* and *Condition* as a random slope over *item*.

Due to convergence issues and singular fit warnings, the maximal model was simplified in a stepwise way. We first simplified the random effects structure by testing if the random slope terms could be omitted without decreasing the fit of the model. Second, the fixed effects part was simplified by testing which interactions were not significant; for this, we used the *drop1* function from the basic stats package in *R* (version 4.1.2) Based on the output that we received from the *drop1* function, we decided which interactions could be dropped from the model (*Condition*Verb*Grade*, and *Condition*Grade* were not significant). Lastly, the conditional and marginal R^2 values of the final model, which are measures of effect sizes, were calculated using the *rsquared* function from the piecewiseSEM package (version 2.1.0., Lefcheck, 2016).[10]

3. Results

In total, we collected 8,319 answers to the active and passive descriptions of our pictures. There were 7,700 correct answers (92.60%), 578 incorrect answers (6.95%) and 41 missing values (0.493%).

For the active condition, the *higher* grade provided 2321 correct answers (97.8%), 39 incorrect answers (1.64%) and there were 11 missing values (0.46%). For the passive condition, the higher grade provided 2272 correct answers (95.8%), 93 incorrect answers (3.92%) and they did not give an answer on 6 trials (0.25%).

For active sentences, the *lower* grade gave 1649 correct answers (92.2%), 136 incorrect answers (7.61%) and there were 3 missing trials (0.17%). For passive sentences, the lower grade provided 1458 correct answers (81.5%), 310 incorrect answers (17.3%) and there was no answer for 21 trials (1.17%). Figure 2 shows the number of correct and incorrect answers per sentence condition per grade. However, note that the percentages are slightly different from the percentages listed below since we did not include the missing values in the plot and in further analyses.

[10] We conducted exploratory analyses to investigate whether there was an interaction between Zipf-frequency * Verb and an interaction between AoA (age of acquisition) * Verb, but we found no interaction between these variables. For this reason, we decided to exclude the Zipf-frequencies and AoA values from our main analysis (see Appendix S7 for these values per verb). Throughout the rest of the paper, further comments on verb frequencies and AoA are thus rather descriptive than drawn from inferential statistics.

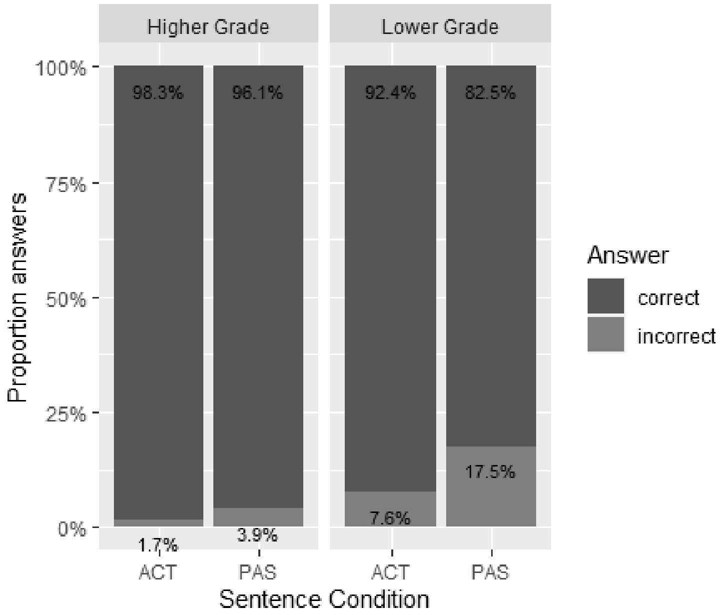

Figure 2 Proportion of correct and incorrect answers per sentence condition and per grade**.**

Our final model consisted of a significant two-way interaction between *Condition*Verb* ($p <$ .001), a two-way interaction between *Verb*Grade* ($p < .001$), and *participant* and *item* as random intercepts. The fixed effects of the final model explained 14.84% of the variance (marginal R^2; Nakagawa & Schielzeth, 2013) and conditional on the random effects, they explained 21.10% of the variance (conditional R^2; Nakagawa & Schielzeth, 2013). Table 1 only shows the significant results in the output for the final model.

Table 1

Final model output with the predictors *Condition* (active condition as reference level), *Verb* (aanrijden as reference level) and *Grade* (high grade as reference level). We only report the significant results in this table (see Appendix S9 for the full model output). (*N* =8278; log-likelihood = -1594.9)

Fixed effects	**β-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	-5.58	0.51	-10.89	< .001***
Condition (passive)	1.55	0.40	3.86	<.001 ***
Verb (inhalen)	2.37	0.58	4.06	<.001 ***
Verb (vervangen)	2.69	0.58	4.62	<.001 ***
Grade (low)	1.80	0.41	4.37	<.001 ***
Condition (passive) * Verb (blokkeren)	-1.89	0.56	-3.37	<.001 ***
Condition (passive) * Verb (inhalen)	-1.12	0.46	-2.41	<.05 *
Condition (passive) * Verb (roepen)	2.11	1.06	1.98	<.05 *
Condition (passive) * Verb (volgen)	2.30	0.81	2.82	<.01 **
Verb (groeten) * Grade (low)	1.52	0.70	2.18	<.05 *

The negative estimate for the intercept indicates that children provided significantly more correct answers (β = -5.58, $p < .001$) to active sentences than to passive sentences. There was thus a significant increase in the number of incorrect answers for passive sentences compared to active sentences, which is noticeable in the strong effect for the predictor *Condition* (β = 1.55, $p < .001$).

For the verbs, we found a significant effect for “inhalen” (to overtake): the positive estimate suggests that this verb significantly rendered more incorrect answers to the target pictures in comparison to the reference verb “aanrijden” (to hit) in active sentences (β = 2.37, $p < .001$). We found the same effect for the verb “vervangen” (to replace) (β = 2.69, $p < .001$).

The positive estimate for the predictor *Grade* (with high grade as reference level) suggests that children in the lower grade significantly provided more incorrect answers in the reference level than children in the higher grade (β 1.80, $p < .001$) (see also Figure 3 for the percentages).

Though there was a significant interaction between *Condition * Verb* ($p < .001$) (obtained by the *drop1* function), this was not the same for all levels of the predictor *Verb*. That is, we found a significant interaction between *Condition* and the verb “blokkeren” (to block”). The negative estimate suggests that, in contrast with the active condition, the number of incorrect answers for “blokkeren” in the passive condition was lower than for the reference verb “aanrijden” (to hit) (β = -1.89, $p < .001$) (see Figure 3). Moreover, the negative estimate of the interaction between *Condition* and the verb “inhalen” (to overtake) suggests that the effect of *Condition* was smaller for this verb than for the reference verb (β = -1.12, $p < .05$). We also found a significant interaction between *Condition* and the verb “roepen” (to call) (β = 2.11, $p < .05$). As the estimate is positive, the effect of *Condition* is larger for this verb than for the reference verb “aanrijden”. We observed the same effect for the significant interaction between *Condition* and the verb ‘volgen’ (to follow) (β = 2.30, $p < .01$): here, the increase in the number of incorrect responses in the passive condition was also larger in comparison with the reference verb (see Figure 3).

There was also a significant interaction between the verb “groeten” (to greet) and *Grade*. The positive estimate indicates that children in the lower grade provided more incorrect answers for this verb compared to the reference level than children in the higher grade ($\beta = 1.52$, $p < .05$).

Note that we did not find a significant interaction between *Condition*Grade*, though, descriptively, it seems that children in the lower grade provided more incorrect answers in passive sentences than in active sentences compared to children in the higher grade (see Figure 3). Due to the variance in the many words that we used, the interaction between *Condition* and the two grades might have not been statistically significant.

Figure 3 The proportion of correct and incorrect answers to each verb per sentence condition per grade. Note that the plot is flipped for it to fit on the page due to the different verbs. The

dark grey bars indicate the correct answers and the light grey bars the incorrect answers. The most important information from these two bar plots is that participants from the lower grade provided more incorrect answers on specific verbs (aanrijden, bedienen, bellen, dragen, groeten, helpen, roepen, slepen, en volgen), especially when those verbs were presented in a passive sentence, compared to participants from the higher grade.

Because the effect for each verb on the outcome variable was compared to only one verb (the reference level "aanrijden" [to hit]), we performed pairwise comparisons using the *emmeans* function (from the package 'emmeans', Lenth 2019) to investigate whether the verbs significantly differed from each other (see Table 2). From Table 2, it seems that the verbs "inhalen" (to overtake) and "vervangen" (to replace) were indeed more difficult to comprehend for the children compared to the other ten verbs (see also Figure 3).

Table 2

Pairwise comparisons of the verbs. In the first column, the first verb significantly rendered more correct answers than the second verb. In the second column, the second verb produced more correct answers than the first verb.

More **correct** answers for the **first** verb than for the **second** verb	More **correct** answers for the **second** verb than for the **first** verb
aanrijden – inhalen: Z= -5.47, p <.001	*inhalen – slepen*: Z= 5.22, p <.001
aanrijden – vervangen: Z= -5.19, p <.001	*inhalen – roepen*: Z= 4.92, p < .001
bedienen – inhalen: Z= -5.07, p <.001	*vervangen – volgen*: Z= 4.92, p <. 001
bedienen – vervangen: Z= -4.85, p <.001	
bellen – inhalen: Z= -5.87, p <.001	
bellen – vervangen: Z= -5.65, p <.001	
blokkeren – inhalen: Z= -4.72, p <.001	
blokkeren – vervangen: Z= -4.46, p <.001	

dragen – inhalen: Z= -6.27, p <.001	
dragen – vervangen: Z= -6.02, p <.001	
groeten – inhalen: Z= -4.41, p < .001	
groeten – vervangen: Z= -4.18, p <. 01	
helpen – inhalen: Z= -5.29, p <.001	
helpen – vervangen: Z= -5.04, p <.001	
roepen – vervangen: Z= -4.74, p <. 001	
slepen – vervangen: Z= -4.96, p <.001	

4. Discussion

In this study, a group of 200 Dutch monolingual Dutch children indicated whether our 208 color drawings depicting transitive action events could be interpreted equally well with an active and a passive sentence. Generally, we found that the children provided 93.02% correct answers to the pictures when an active or a passive sentence was used to describe a transitive event in a picture. In total, there were only 6.98% incorrect answers to the pictures. These results imply that our pictures can be interpreted with both transitive structures and are suitable for language studies with (Dutch) children.

Though the children performed well on the task, we specifically investigated what factors contributed to incorrect answers. This is important to know as these factors may provide valuable information for other researchers who want to use our picture set in their study. There were several factors that may have contributed to incorrect answers: (1) the use of an active or a passive sentence to describe a picture; (2) the verb that was used to describe the transitive action in a picture; (3) and the age of the children that we tested (we tested children in two different grades, a lower [6-7 years] and a higher grade [11-12 years]).

The strong main effect for our predictor *Condition* indicates that the children had more difficulty interpreting a picture when a passive sentence was used to describe a transitive event than when an active sentence was used. From early on, children receive little input to learn the passive structure. For instance, Gordon and Chafetz (1990) only found four full English passives in a corpus of 87,000 child-directed utterances. Moreover, it takes a while before school-age children (6 years and older) have acquired an adult-like interpretation of complex structures, such as passives (Montgomery et al., 2017). More importantly, all our sentences were reversible passives. That is, the agent and patient of the passive structure can be exchanged while the sentence remains correct (e.g., "*De bakker wordt gegroet door de leraar*" - "The baker is being greeted by the teacher". As mentioned in the introduction, reversible passives are challenging for children because they have difficulty interpreting who does what to whom (see for a review Armon-Lotem et al., 2016). Non-reversible passives are easier to comprehend because children can rely on world knowledge to infer the meaning of the passive structure (e.g., The gras is being eaten by the cow). Researchers who intend to use our materials to investigate transitive comprehension in (Dutch) children should thus be aware of the fact that our pictures only consist of reversible passives. If our materials included non-reversible passives, it is possible that we might have observed a less strong effect for *Condition*.

We also tested to what extent the verb, describing the transitive event on our pictures, affected the number of incorrect interpretations of the transitive action. We found that the verbs "inhalen" (to overtake) and "vervangen" (to replace) produced significantly more incorrect answers to the pictures compared to our reference verb "aanrijden" (to hit) in active sentences. There could be several explanations for why these two verbs were significantly more difficult for children to comprehend than the other ten verbs that we used in our stimuli. We believe that the combination of these verbs together with how they were depicted on our pictures might have impeded the children's inferences of these pictures compared to pictures that depicted concrete verbs (e.g., the verb "dragen" [to carry]). For instance, pictures with the verb “inhalen” were drawn from a bird’s eye view perspective (see Figure 1 for an example). The bird’s eye view may have hindered children’s comprehension of “inhalen” because it might have been difficult to parse what is overtaking what. Even though we used arrows to indicate what object was performing the act of overtaking another object, it is likely that using arrows to indicate a motion might have been too abstract for the children. In this case, they do not only have to infer the meaning of the verb, but also the meaning of a “static” arrow that depicts a motion. The same argumentation can be made for the verb “vervangen” (see Appendix S8). Not only is “vervangen” a rather abstract verb, its depiction on our pictures may have also contributed to difficulties in processing the transitive event. More specifically, we depicted the transitive action of “replacing” with a red cross. For instance, for the sentence, “*De ambulance vervangt de bus*” [“The ambulance replaces the bus”], we put a red cross through “the bus”; this was supposed to indicate that this object was replaced by the other object that did not have this cross (see Appendix S8). It is very likely that the combination of the picture and the verb may thus have caused processing difficulties for the children. Moreover, it could be possible that the children in our study might not have been familiar with both verbs, as these verbs are learned relatively late (“inhalen” is learned at 8;61 years and “vervangen” at 9;06 years, see Brysbaert et al., 2014). In our exploratory analyses, where we tested whether there was an interaction between *Verb* and AoA (age of acquisition), we did not find a significant interaction between these two variables. However, we still believe that some children (especially the younger ones) might not have acquired these two verbs yet at the time of testing. For this reason, this might have increased effortful processing of the pictures that contained these two verbs.

We also anticipated that comprehending some verbs could be even more difficult when they were used in passive sentences. Two verbs produced more incorrect answers to the pictures when a passive sentence was used compared to the reference verb “aanrijden” (to hit) in active sentences, namely, “roepen” (to shout) and “volgen” (to follow). Although “roepen” and “volgen” are learned somewhat early by Dutch children, (“roepen” is learned at the age of 4;96 years and “volgen” is learned at 5;84 years, Brysbaert et al., 2014), there could be other explanations for why these verbs produced significantly more incorrect answers to the pictures when they were used in a passive sentence. One could argue that the verb “roepen” (to shout) is a so-called *action verb,* which implies that this verb, ideally, appears in a sentence where the agent is in the subject position and the patient is in the direct object position of a sentence (Lempert, 1989). In other words, it may be that this verb is tightly linked to an argument structure that is compatible with how an active sentence is formed. Although “roepen” can equally occur in an active and a passive sentence, the verb’s syntactic preference (i.e., verb bias, see Peter et al., 2015) may affect which syntactic structure children (and other speakers) expect the verb to occur in. What is more, it is likely that children are more frequently exposed to this verb in active sentences than in passive sentences. Thus, when “roepen” occurred in the unexpected passive sentence, the children might have had difficulty to parse who called whom in the picture (i.e., it is likely that the first noun was interpreted as an agent instead of a patient, leading to an incorrect answer for the passive interpretation of a picture). For “volgen” (to follow), the situation is a bit different. We believe that the pictures containing this verb might have caused some confusion for the children. In the pictures with the verb “volgen”, we used an arrow to indicate what followed what. For instance, for the sentence “the car follows the truck”, we used an arrow to display the direction of the transitive event (an arrow was placed between the agent and the patient, see Appendix S10). The arrow might have caused participants to automatically interpret the first noun as the agent (“the car”) followed by the patient (“the truck”). In the case that the picture was described with a passive instead, children had to disregard the direction of the arrow, since the patient was mentioned first. For this reason, we assume that, since the arrow might have prompted an active interpretation of the transitive event, the children might have had difficulty comprehending what followed what when a passive sentence was used, leading to more incorrect answers for passives as opposed to actives.

We found the opposite effect for the verbs “blokkeren” (to block) and “inhalen” (to overtake). It seems that these verbs produced significantly more correct answers in passive sentences compared to our reference verb “aanrijden” (to hit) in active sentences. The pictures in which these verbs were depicted always consisted of an inanimate agent and an inanimate patient (e.g., “*De vrachtwagen haalt de auto in*” – The truck overtakes the car; “*De vrachtwagen blokkeert de auto*” – The truck blocks the car). Several studies (see Bock, 1986; Gàmez & Vasilyeva, 2015) have shown that people have the tendency to produce passive sentences over active sentences when they encounter an inanimate actor and an animate undergoer. In our case, sentences with both transitive verbs (“blokkeren” and “inhalen”) had an inanimate agent and patient. However, it could be the case that when children encountered the first inanimate noun, they might have activated a passive sentence over an active sentence since the grammatical subject of the sentence was inanimate. Possibly, this could have facilitated the processing of pictures that contained these verbs.

Lastly, as expected, we found that the children in the lower grade provided more incorrect answers to the pictures (either described with active or passive sentences) than the children in the higher grade. This means that the older children were better at matching our pictures to the correct transitive structure younger children. Additionally, we found a significant interaction between the verb “groeten” (to greet) and *Grade*: children in the lower grade significantly made more errors in interpreting pictures with this verb in active sentences compared to children in the higher grade. An explanation for this could be that “groeten” is a rather formal word that young children would not necessarily use themselves. More importantly, “groeten” is acquired at the age of 6;71 years (see Brysbaert et al., 2014), which implies that the children in the low grade might not have been familiar with this verb yet (or they might be familiar with this verb only in specific contexts), while the older children might have already known this verb. Another explanation could be that the transitive action of this verb was probably not clear on its pictures. The pictures with the verb “groeten” have two animate objects where the agent is holding one hand up (indicating the action of “to greet”) while the patient is portrayed statically on the picture. It could be that the action event of the agent greeting the patient was not depicted explicitly enough, since the only indication for it is the agent’s hand being held up. Children in the lower grade might have overlooked this important feature while trying to comprehend pictures with the verb “groeten”, leading to incorrect answers.

5. Limitations and Future Directions

Though we chose to construct our picture set for Dutch language users, since, to our knowledge, no such set exists yet, we admit that this also comes with some disadvantages. As Dutch is only spoken in a few countries (the Netherlands, Belgium, and former Dutch colonies, such as Surinam, Curaçao, the country of Sint Maarten and Aruba), the use of this picture set may be limited. Of course, the transitive verbs can be translated to English (and other languages), which allows these pictures to be used in studies involving speakers of English. However, ideally, before using it in studies with, for instance, English speakers, one would first have to investigate whether the English variant of our picture set produces approximately the same number of correct interpretations of the transitive events in our pictures (either described with an active or a passive sentence).

We are aware that the current study addresses verb frequency and the age of acquisition of the verbs descriptively. Because our materials were initially developed for late L2 learners of Dutch, we used verbs that were familiar to them. Prior to conducting this study, we did not test whether the children also knew these verbs and whether they had already acquired them or not (as we were mainly interested in whether children were able to interpret our pictures equally well with an active and a passive structure). For this reason, if researchers intend to use our materials to test, for instance, the online processing of transitive structures, it should be noted that lexical frequency may affect sentence processing (Huizeling et al., 2022). We emphasize, however, that the children only provided 7% incorrect answers, which means that we should not overlook the fact that our materials did largely elicit correct interpretations of both active and passive descriptions of transitive events (93%).

Another possible limitation is that we used our picture set to investigate the comprehension of active and passive events in a group of children who were already relatively far into their L1 syntax acquisition. As we know that children start understanding passives around the age of 3, we do not know whether this picture set is also suitable for the youngest group of language users. Because of the findings in the current study (it turns out that our picture set contains a few transitive verbs that are learned quite late by Dutch children), we believe that our picture set might probably be too complex for children younger than the age of 6. For this reason, we advise researchers to use our picture set for children in the same age group as the one we tested (6 – 12 years old).

Throughout this article, we used studies in structural priming involving children as a possible research domain for which our picture set can be used. However, we would like to stress that our picture set may be suitable for other research domains too, particularly in domains where sentences are elicited. Since our picture set was initially designed for longitudinal designs, our set can be useful to test the acquisition of transitive structures in children, especially the use of passives. Research has shown that passive sentences are quite difficult for children to such an extent that, even when they have already learned the passive structure, their passive sentence production remains effortful (Messenger et al., 2012). As our norming study showed that the younger children made more errors in *comprehending* pictures that were described with a passive sentence compared to the older children, future studies could investigate whether younger children also make more errors while *producing* passive sentences, and at what age the number of errors decreases. Apart from using our picture set to investigate the acquisition of transitives in typically developing children, our stimuli can also be used in studies that involve children with a delayed language development (e.g., children on the autism spectrum) as acquiring passives has been found to be even more effortful for them compared to children without such a delay (Ambridge et al., 2021). Moreover, because our picture set uses a limited vocabulary (verbs and nouns), we believe that it may not too taxing on the language abilities of, for instance, people with a language impairment. We also think that, for the same reason, our picture set can be used in studies with healthy elderly people.

Lastly, we tested the comprehension of transitive structures, but our pictures could also be used in other modalities such as language production (spoken as well as written, see Van Lieburg et al. [Chapter 2], who already used our picture set to investigate L2 syntax production). An interesting question could be whether language users spontaneously describe a transitive event with the more complex passive sentence structure or whether they will almost always produce active sentences because they are easier. This question is especially interesting for written language production, as research has shown that people use passives more spontaneously during writing than in spoken language (Hinkel, 2004).

6. Conclusion

This study set out to test whether our picture set, consisting of transitive events with different verbs, could be interpreted equally well with active and passive sentences amongst Dutch children who differed in age. Even though the children provided 93.02% correct answers, we found that they provided significantly more incorrect answers to pictures that used a passive sentence to describe a transitive event than to pictures that used an active sentence. Moreover, we found that some verbs (“inhalen” and “vervangen”) significantly produced more incorrect answers regardless of whether they were presented in an active or a passive sentence compared to the other verbs that occurred in our pictures. Moreover, we observed that the children had difficulty in comprehending some verbs when they were presented in a passive sentence, while other verbs rendered more correct answers when the transitive event was described with a passive sentence. We also found that, in general, younger children had more difficulty in interpreting our pictures, either described with an active or a passive sentence. Only one verb seemed to be particularly difficult for the younger children, namely, the verb “groeten” (to greet). We believe that the relatively late age of acquisition of this verb (6;71 years) and the unclear depiction of the transitive action “groeten” on pictures could have hindered the young children’s comprehension of this verb.

Altogether, our study shows that the colored pictures are mostly clear in terms of how the transitive events are displayed and how well they can be interpreted with either an active or a passive sentence by young children

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CHAPTER 7

GENERAL DISCUSSION

The main goal of this project was to investigate how late second language learners develop and establish structural representations of both similar and dissimilar L2 syntactic structures throughout their learning trajectory. To address this question, I conducted structural priming experiments in which I tested the predictions of Hartsuiker and Bernolet's (2017) developmental account of L2 syntactic acquisition. According to their account, late second language learners start with item-specific L2 representations that gradually evolve into abstract syntactic representations. Over time, these L2 abstract syntactic representations become shared with existing L1 syntactic representations, whenever the L1-L2 syntactic structures are *similar* enough. The abstraction process is influenced by the relative frequency of L2 syntactic structures and L2 proficiency, with abstract syntactic representations being formed earlier for frequent syntactic alternants (actives) than for less frequent ones (such as passives). Additionally, advanced bilinguals are expected to show abstract L2 structural priming and cross-language structural priming, while less advanced bilinguals will only show within-L2 priming in conditions with lexical overlap.

In this dissertation, I focused on several questions related to the predictions of Hartsuiker and Bernole's developmental account. (1) In Chapter 2, I investigated the nature of the learning trajectory of active and passive sentences in late learners of Dutch, who acquired this language in an ecologically valid context (Muylle, 2021a, used an artificial language to address this question). Additionally, in the same chapter, I examined whether a lexically-based intervention block could promote the formation of abstract structural representations of passive sentences, as beginning L2 learners are expected to rely heavily on lexical overlap for structural priming to occur.

(2) In Chapter 3, I examined a scenario in which second language learners are confronted with learning a morphosyntactically dissimilar, yet highly frequent, L2 syntactic structure (active sentences in Spanish that are dissimilar from active sentences in Dutch), as well as a similar, but less frequent, L2 syntactic structure (Spanish passive sentences that are structurally similar to passives in Dutch). To investigate this, I conducted a cross-language structural priming experiment involving Dutch-Spanish bilinguals, who had varying levels of Spanish proficiency. The experiment included both within-language (Spanish-Spanish) and between-language trials (Dutch-Spanish). Moreover, I employed a lexically-based intervention block to investigate whether this would boost the production of both transitive alternants in subsequent trials without lexical overlap. This design allowed us to investigate whether less advanced learners of Spanish would only show within-language priming and between-language priming for the similar, but less frequent, passive structure. Furthermore, we aimed to determine if more advanced learners of Spanish would demonstrate *active* priming within the L2, as well as passive priming in both the L2 and between the L1 and L2.

(3) In Chapter 4, I investigated whether learners of Dutch with L1 French can be primed to produce the dissimilar PP-medial passive in Dutch when the similar syntactic alternant, namely, the PP-final passive, is available to these learners. Importantly, this study aimed to examine the idea that the presence of a similar L1-L2 syntactic structure might impede the learning of the dissimilar L2 syntactic structure (Muylle et al., 2021b, used an artificial language to investigate the same question). To answer the research question posed in this chapter, I focused on the role of L2 proficiency on the production preferences and the priming of both passive alternants in the late learners of Dutch. Building on the findings in

Chapter 4, which showed that French-speaking learners of Dutch preferred using the dissimilar PP-medial passives due to explicit language teaching, Chapter 5 aimed to investigate whether an increase in the proportion of PP-final passive primes would promote a higher frequency of usage of this structure during L2 syntactic production.

(4) Finally, in Chapter 6, I examined whether the stimuli used in Chapters 2 and 3 can be used in research involving different populations, specifically, in the investigation of transitive acquisition in children. In the upcoming section, I will discuss the overarching research questions in more detail, referring to the relevant chapters as appropriate.

1. When and to what extent do late second language learners show priming for active and passive sentence structures?

One of the main objectives of this project was to examine how and when L2 learners develop L2 structural representations in an ecologically valid context. This choice was motivated by the fact that Muylle et al.'s (2021a) artificial language study did not provide conclusive evidence for the development of abstract L2 structural representations. The longitudinal study in Chapter 2 showed evidence supporting the assumption that priming occurs earlier for more frequent structures (actives) compared to less frequent ones. However, after the first session of the longitudinal study, we did not observe passive priming in subsequent sessions. It is important to note that we only observed an increase in passive responses over sessions, which suggests that the abstract passive representation might have strengthened in participants' memory across sessions. Nonetheless, due to the relatively rapid formation of the abstract passive representation, we were unable to investigate its gradual development over multiple sessions.

The only cross-language structural priming experiment in this project is reported in Chapter 3. Based on the predictions of Hartsuiker and Bernolet's developmental account, we anticipated observing within-language priming (specifically, priming of the similar passive structure) before observing between-language priming. However, we did not find an effect of the prime language (Spanish primes followed by Spanish targets and Dutch primes followed by Spanish targets). It is important to note that the absence of an effect does not imply the absence of a difference between within- and between-language priming. Unfortunately, our sample size in the study with Dutch learners of Spanish was insufficient to examine whether within-language priming takes place before between-language priming. Therefore, future studies should aim to include a larger number of participants to achieve the necessary statistical power for investigating these priming effects more effectively.

2. The role of L2 proficiency on L2 production preferences and priming of L2 syntactic alternants

An important prediction of Hartsuiker and Bernolet's developmental account is that as L2 proficiency increases, second language learners will show stronger abstract structural priming effects, initially within the L2 and subsequently between both languages. Throughout all empirical chapters in this dissertation, second language proficiency was an important predictor for L2 structural preferences and the magnitude of structural priming of L2 syntactic alternants.

In Chapter 2, we examined the role of L2 proficiency on the priming of Dutch transitives using two experimental designs: a longitudinal study and a cross-sectional study. In our longitudinal study, consisting of five sessions, we investigated the process of establishing syntactic representations for both the active and passive structures among late learners of Dutch. Anticipating that learners would become more proficient with each session, we also expected to observe stronger abstract passive priming, indicating the gradual establishment of an abstract structural representation for the passive structure. We indeed found an increase in the usage of passives over sessions, suggesting that the abstract structural representation for the passive structure became stronger in later sessions compared to earlier ones. However, we did not observe passive priming in the later sessions of the longitudinal study. This finding contradicted our initial expectations. Nonetheless, it does not necessarily imply that these learners had not yet established an abstract structural representation for the passive structure, as they were proficient enough to produce it. The limitations (see Chapter 2 for more on these) of the longitudinal design prevented us from accurately investigating the effects of L2 proficiency on the abstraction process. Specifically, the learners had likely become aware of the two different transitive structures being tested, leading them to choose the more complex syntactic structure to demonstrate their ability to produce this alternative form, rather than the easier active sentence structure.

In the cross-sectional study of Chapter 2, our expectation was that higher proficiency learners would show stronger passive priming compared to lower proficiency learners, as the former group was presumed to be further along in their learning trajectory. However, contrary to our anticipated structural priming pattern, we found passive priming in both the less proficient and the more proficient learners. This finding suggests that the less proficient learners were likely not at the very beginning stages of their learning trajectory. It is highly probable that the lower proficiency learners had already been exposed to the passive structure, which resulted in them demonstrating passive priming of equal strength to that of the higher proficiency speakers.

Taken together, our longitudinal and cross-sectional studies demonstrate that an increase in L2 proficiency corresponds to an increased production of passives. This finding suggests that the development of abstract structural representations for more complex syntactic structures relies on L2 proficiency. However, due to practical limitations in both studies (see Chapter 2), we were unable to accurately measure participants’ proficiency using a single variable (the LexTALE language test [Lemhöfer & Broersma, 2012], was administered only during the fourth session of the longitudinal study). Consequently, the role of L2 proficiency in the various stages of L2 syntactic acquisition remains somewhat unclear, particularly in ecologically valid learning contexts where multiple factors come into play (unlike using an artificial language, where external factors are kept to a minimum, see Muylle et al., 2021a). For instance, factors such as different first languages amongst learners and/or prior knowledge of an Indo-European language can play a role in how successful one's learning trajectory is. This is demonstrated in Schepens et al. (2013), who found that learning difficulty increases as the linguistic distance between the first language and Dutch increases. Therefore, it is likely that these factors may (equally) contribute to the establishment of L2 structural representations.

In Chapter 3, we approximated participants' proficiencies in Spanish using the Spanish version of the LexTALE language test (Izura et al., 2014). Our structural priming study consisted of within-language (Spanish-Spanish) and between-language (Dutch-Spanish) trials to investigate the priming of active and passive sentences. Recall that the active structure in Spanish, though the more frequent transitive alternant, is morphosyntactically dissimilar from the active structure in Dutch ("*El panadero ayuda a la cantante*" – "*De bakker helpt de zangeres*" [The baker helps the singer]), while the passive structure, the less frequent alternant, is similar between Dutch and Spanish ("*La cantante es ayudada por el panadero*" – "*De zangeres wordt geholpen door de bakker*" [The singer is being helped by the baker]). According to our expectations, advanced L2 learners would be more likely to correctly produce the morphosyntactically dissimilar active structure compared to less advanced learners, increasing the odds for active priming to occur. In contrast, less advanced learners would likely produce the similar L2 syntactic structure, as they can use the shared L1 syntactic representation for this. In our baseline condition, we found a main effect of L2 proficiency. Specifically, as L2 proficiency increased, learners produced more *active* sentences in the baseline condition while the proportion of passives decreased. Though the proportion of active responses increased per unit increase in the L2 proficiency, we did not find active priming. Instead, it seems that higher proficiency L2 learners were less hesitant to produce an active sentence compared to lower proficiency learners. We believe that, in this case, upon increasing L2 proficiency, second language learners tend to adapt toward native-like language expectations (as suggested by Montero-Melis & Jaeger, 2019). Specifically, native speakers of Spanish rarely use passive constructions during language production. Therefore, the higher proficiency learners might have been aware of this, and as a result, used more actives than passives. Interestingly, we observed a significant interaction between L2 proficiency and passive priming, even though the proportion of passives decreased upon increasing L2 proficiency. Specifically, as proficiency increased, the proportion of passives in in the baseline condition decreased (while the proportion of actives increased), and the proportion of passives in the passive prime condition also decreased. However, the decrease of passive responses in the baseline condition was much steeper than the decrease of passive responses in the passive prime condition. As a result, the more proficient Spanish learners showed *positive* passive priming compared to the less proficient learners. These findings differ from what is usually reported in structural priming studies, where increasing proficiency leads to an overall *increase* in the use of passives in both the baseline and the passive prime condition. However, the increase is typically more pronounced in the passive prime condition, resulting in significant passive priming with increasing L2 proficiency (Kim & McDonough, 2008). Thus, it appears that employing a baseline condition in structural priming experiments is crucial as it indicates for which syntactic alternant the priming effect is influenced by L2 proficiency.

In Chapter 4, we utilized the Dutch version of the LexTALE language test (Lemhöfer

& Broersma, 2012) to assess participants' proficiencies. This chapter provides additional data supporting the assumptions that L2 proficiency plays a crucial role in shaping the structural preferences of L2 learners and that it also influences the magnitude of structural priming of L2 syntactic alternants. Namely, low proficient learners of Dutch with L1 French showed a production preference towards the dissimilar L2 PP-medial passive structure in the baseline condition. This is because the low proficient learners relied more heavily on this explicitly taught passive form. As a result, lower proficiency learners demonstrated stronger PP-final priming compared to higher proficiency learners (which is in line with the inverse-frequency effect, Chang et al., 2006). In contrast, highly proficient L2 learners were more likely to produce the similar PP-final passive structure than the dissimilar PP-medial passive structure in the baseline condition. The higher proficiency learners had likely implicitly adapted to a native-like language distribution of passive alternants. Consequently, we observed that PP-medial priming was influenced by L2 proficiency, with stronger PP-medial priming observed as proficiency increased. It is important to note that we found evidence for the presence of the blocking effect (similar to Muylle et al., 2021b), although this effect was strongly influenced by explicit language instruction. The blocking effect is the phenomenon where the prior association between similar syntactic structures "blocks" the learning of associations between dissimilar structures. In the context of language learning, the blocking effect suggests that when learners encounter similar structures or patterns first, their attention and learning resources become focused on those similarities. As a result, when they later encounter dissimilar structures or patterns, they may find it more challenging to establish new associations because their attention is already "blocked" or directed towards the previously learned similar structures. In our case, it seems that lower proficiency learners had a strong association with the PP-medial passive structure when formulating a Dutch passive structure. Therefore, it was more challenging for them to learn that the PP-final passive structure shares a syntactic representation with their L1 passive form.

The assumptions and findings in Chapter 4 were further supported by our structural priming experiment in Chapter 5. In this experiment, we increased the proportion of PP-final passives in our primes to boost the production of these sentences in the target trials amongst French-Dutch bilinguals. Our manipulation resulted in an increased usage of PP-final passives in the baseline condition. Consistent with the findings in Chapter 4, we observed that higher proficiency learners demonstrated a higher production rate of PP-final passives compared to PP-medial passives in the baseline condition. As a result, this facilitated stronger PP-medial passive priming (in line with the inverse-frequency effect, Chang et al., 2006), while PP-final passive priming significantly decreased with increasing L2 proficiency.

In summary, the structural priming experiments conducted in the empirical chapters of this project have provided evidence supporting the idea that L2 proficiency plays an important role in shaping L2 structural preferences and, importantly, in influencing the magnitude of structural priming effects of syntactic alternants. While Hartsuiker and Bernolet's developmental account predicted the impact of L2 proficiency on abstract structural priming of similar L2 structures, our findings demonstrate that L2 proficiency also equally affects abstract structural priming of dissimilar L2 structures. The role of L2 proficiency on the production and priming of dissimilar L2 structures appears to be twofold: (1) as proficiency increases, L2 learners are more likely to produce (morphosyntactically) dissimilar structures (e.g., actives in Spanish), and simultaneously, (2) increasing L2 proficiency seems to influence L2 learners to adapt to both a more native-like structural preference pattern and structural priming pattern. Moreover, based on our longitudinal and cross-sectional study, it seems that the absence of abstract structural priming for less frequent (and complex) L2 structures should not be interpreted as an indication that L2 learners have not developed an abstract structural representation for these structures as their proficiency increases. Instead, an increase in second language proficiency appears to motivate learners to actively choose to produce the more complex L2 syntactic structure rather than their simpler syntactic counterpart.

3. Using structural priming as an intervention method to boost the production of infrequent or less preferred L2 syntactic structures

Another assumption of Hartsuiker and Bernolet's developmental account is that beginning L2 learners, who are at the early stages of their learning trajectory, rely heavily on lexical overlap between prime and target sentences for structural priming to occur. This lexical overlap serves as a cue to the explicit memory of the prime sentence, and participants may employ a copy-edit strategy to describe the target picture (Bernolet et al., 2016). As a result, it is possible to observe priming effects even in the absence of an abstract structural representation for the more complex structure. Therefore, an important question in Chapters 2 and 3 was to investigate whether a few instances of verb overlap could serve as an intervention to promote the production of infrequent and/or less preferred L2 syntactic structures in subsequent trials without verb overlap.

In our longitudinal and cross-sectional study, we implemented a lexically-based intervention block halfway through the experiment, which consisted of four passive sentences. In the longitudinal study, we observed that participants produced more passives after the intervention items compared to before the intervention items, particularly during the earlier sessions. As expected, this result suggests that, in the earlier stages of L2 syntactic learning, learners benefit from lexical overlap, as they still rely on item-specific representations rather than abstract structural representations[1]. In the cross-sectional study,

[1] It is unlikely that the increase in passives after the intervention block was due to cumulative priming effects. Our results show a direct increase in the proportion of passives immediately following the first prime-target sentences with lexical overlap. This implies that the increase in passives was more likely a result of our lexically-based intervention rather than cumulative priming effects.

we found a boost of passives due to the lexical intervention in both the lower and higher proficiency learners. This finding differs from the earlier sessions of the longitudinal study, suggesting that the low proficient learners in the cross-sectional study might have already developed an abstract structural representation for passive sentences (e.g., in comprehension), resulting in reduced reliance on lexical repetition.

In Chapter 3, we also implemented a lexically-based intervention block halfway through the experiment. In the within-language condition (Spanish primes – Spanish targets), the intervention block consisted of two active sentences. In the between-language condition (Dutch primes – Spanish targets), it consisted of two passive sentences. Recall that our objective was to raise awareness among the learners, particularly those with lower proficiency, regarding the different realizations of the active structure in Spanish. Additionally, we aimed to encourage the learners to produce the passive structure during the between-language trials, as the passive structure is similar between Dutch and Spanish. We observed an increase in the production of passive sentences in all prime conditions after the intervention block compared to before the intervention block. Importantly, the increase in passives was not limited to the passive prime condition alone. Rather, it appears that the two passive sentences with lexical overlap had a significant impact on the usage of the passive structure, regardless of the prime condition. Interestingly, the results reported in Chapter 3 indicate that the lexically-based active prime and target sentences positively affected the correct formulation of this structure in subsequent trials without verb overlap. Specifically, we observed fewer incorrect active sentence structures produced by participants after the intervention compared to before the intervention. This result suggests that even a limited number of instances of items with verb overlap (as few as two trials) can influence the correct formulation of dissimilar L2 structures.

In Chapter 5, we manipulated the frequency of PP-final and PP-medial passives in our prime sentences to increase the production of PP-final passives in target sentences. Indeed, our frequency manipulation led to increased usage of the similar PP-final passive structure in the baseline condition amongst French-Dutch bilinguals, though they had been explicitly taught to use the dissimilar PP-medial passive for the formulation of a passive in Dutch. As a result, we observed stronger PP-medial priming than PP-final priming. This result is difficult to explain based on the predictions of Hartsuiker and Bernolet's developmental account. Though the authors predict that abstract structural representations will be formed earlier for more frequent structures than less frequent ones, they do not explain how frequency impacts representations once L1-L2 similar syntactic structures (such as French and Dutch PP-final passives) have been shared (see Muylle et al., 2021c, for the same reasoning). Since Hartsuiker and Bernolet's developmental account is based on lexicalist frameworks (e.g., Hartsuiker et al., 2004; Pickering & Branigan, 1998), it seems unlikely that a short-term activation mechanism (as proposed in Pickering & Branigan, 1998) can effectively track the increase of one syntactic alternant over another in the language input. This is because such activation is expected to decay quickly. Instead, Hartsuiker and Bernolet propose that implicit learning mechanisms (Chang et al., 2006; Reitter et al., 2011[2]) may be responsible for the formation of syntactic representations, aligning with Muylle (2021c). However, it is important to note that these mechanisms have not yet been implemented in the current developmental account. According to implicit learning accounts, less frequent structures, such as PP-final passives in our case, have weaker connections (Reitter et al., 2011). Consequently, these structures are more sensitive to weight changes, and repeated exposure to them can lead to long-term weight changes (Reitter et al., 2011; cf. Muylle et al., 2021c). This mechanism might explain the increased proportion of PP-final passives responses resulting from our frequency manipulation.

[2] Note that an important aspect of Reitter et al.'s model (2011) is activation-based.

We suggest that increasing exposure to less preferred L2 syntactic structures in the language input could be an effective approach to teaching these structures to late learners of a second language. For instance, Kim and McDonough (2016) found that repeating passive primes (i.e., repeating prime sentences in addition to merely hearing them before formulating a target sentence) facilitated the subsequent production of passives. However, this task may be challenging to beginning L2 learners, as it requires additional working memory resources (McDonough & Kim, 2016). For this reason, increasing exposure to less preferred L2 syntactic structures in the language input may facilitate learners' access to and use of complex, infrequent, or less preferred L2 syntactic structures.

Altogether, based on the discussion of intervention methods, we believe that employing a limited number of trials with lexical overlap and manipulating the frequency of syntactic alternants in the language input, favoring less preferred L2 syntactic structures, have both demonstrated effectiveness in promoting the subsequent (and correct) production of complex and less preferred L2 structures.

Evaluation of Hartsuiker and Bernolet's developmental account of L2 syntactic acquisition and suggestions for an improved account

The results of the structural priming experiments conducted in this project provide some evidence supporting the predictions of Hartsuiker and Bernolet's developmental account of L2 syntactic acquisition. Firstly, we observed active priming in the first session of the longitudinal study (Chapter 2), and this effect diminished in subsequent sessions. This finding supports the assumption that priming occurs earlier for more frequent structures compared to less frequent ones, and that priming for frequent structures decreases as proficiency increases.

Secondly, in Chapter 2, we found data corroborating the hypothesis that beginning L2 learners heavily depend on item-specific representations, as they have not yet developed abstract syntactic representations. Specifically, we observed that participants in the longitudinal study demonstrated a higher frequency of passive production following the lexically-based intervention block in the earlier sessions compared to the later sessions. In line with the predictions of the developmental account, these findings imply that beginning learners benefit more from lexical repetition between prime and target sentences for the production of the passive structure in subsequent trials without lexical overlap, compared to when these learners become more proficient. Thus, in the early stages of L2 syntactic acquisition, lower proficiency learners seem to use lexical overlap as an explicit memory cue when formulating subsequent sentences (Bernolet et al., 2016, Bernolet & Hartsuiker, 2018). We also observed that learners in the cross-sectional study produced more passives after the intervention block compared to before the intervention block. However, contrary to our expectations based on the predictions of Hartsuiker and Bernolet's account, it was not the case that lower proficiency learners in the cross-sectional study produced more passives after the intervention block than higher proficiency speakers. As mentioned before, it is very likely that the lower proficiency learners in the cross-sectional study were further along in their learning trajectory than the learners in the longitudinal study. Nonetheless, the observation that all learners exhibited long-lasting lexical boost effects due to the intervention block cannot be accounted for by Hartsuiker and Bernolet's account, which is based on lexicalist frameworks (e.g., Hartsuiker et al., 2004; Pickering & Branigan, 1998). Furthermore, as mentioned earlier, Hartsuiker and Bernolet suggest that sentence processing causes permanent changes to syntactic representations (in line with the implicit learning account, Chang et al., 2006) in the bilingual's mind. Hence, the authors suggest that the account should include a learning mechanism that not only governs the instantiation and merging of syntactic representations but also tracks the structures it encounters.

Thirdly, our data support the idea that L2 proficiency plays an important role in the development of abstract L2 structural representations. In the longitudinal study, participants produced more passives across sessions, suggesting that the abstract structural representation for the passive structure strengthened with increasing proficiency. Furthermore, in Chapter 3, we observed that higher proficiency Dutch-Spanish bilinguals produced more actives (although not always correctly) than lower proficiency bilinguals. This could imply that the former bilinguals were likely in the process of merging the syntactic representations for the active form in Spanish and the one in Dutch into one representation. Since the higher proficiency bilinguals produced more errors in active sentences compared to the lower proficiency bilinguals, it could be that the process of merging the active syntactic representation in Dutch and the one in Spanish might have caused these errors to occur. Bernolet et al. (2013) found similar results when investigating the priming of English genitives (S-genitives and Of-genitives). Higher proficiency Dutch-English bilinguals produced more S-genitives but also made more syntactic errors, suggesting a potential influence of the shared S-genitive structure between Dutch and English (e.g., saying "**The nun her egg is yellow*" instead of "*The nun's egg is yellow*") on the formulation of the S-genitive in English. Additionally, in Chapter 4 and 5, we observed that higher proficiency French-Dutch bilinguals produced more PP-final passives than PP-medial passives in the baseline condition compared to lower proficiency bilinguals. This suggests that the higher proficiency learners likely developed a syntactic representation for the less preferred PP-final passive structure, whereas the lower proficiency speakers tended to rely more on the explicitly instructed PP-medial passive. Nonetheless, these findings from Chapter 2, 3, 4, and 5 support the idea that the production of complex and less frequent L2 syntactic structures increases with proficiency. Contrary to the predictions of Hartsuiker and Bernolet's account, our experiments did not reveal stronger priming for these structures in higher proficiency bilinguals compared to lower proficiency ones. This discrepancy challenges the assumption of Hartsuiker and Bernolet's developmental account regarding the influence of L2 proficiency on the magnitude of structural priming.

Several findings reported in this dissertation cannot be solely accounted for by Hartsuiker and Bernolet's developmental account. Instead, we propose that the developmental account may benefit from incorporating aspects of implicit learning accounts (Chang et al., 2006; Reitter et al., 2011; Khoe et al., 2021) to enhance our understanding of how L2 learners develop and establish structural representations (as already proposed in Hartsuiker & Bernolet, 2017; see for similar suggestions Muylle, 2020a; Van Lieburg, 2023).

A recurring finding from different experiments throughout this project is that we observed inverse-frequency effects on structural priming (Chang et al., 2006; Jaeger & Snider, 2013; Hartsuiker & Westenberg, 2000). The inverse-frequency effect entails that larger priming will occur for less frequent structures than for more frequent ones due to surprisal caused by prediction errors during syntactic processing. For instance, in Chapter 3, we observed passive priming but did not find evidence of active priming. This outcome is consistent with the predictions of the implicit learning account, as proposed by Chang et al. (2006). Moreover, in Chapter 4, we discovered a stronger PP-final passive priming effect, which can be attributed to participants' baseline production preference for the explicitly instructed PP-medial passive structure. Additionally, in Chapter 5, we observed a stronger PP-medial priming effect compared to PP-final priming, as participants exhibited a preference for PP-final structures in the baseline condition due to our frequency manipulation.

These effects can also be accounted for by the multifactorial account proposed by Reitter et al. (2011). The authors claim that, due to implicit learning processes, highly frequent structures have a higher base-level activation than low frequent structures. Consequently, there is reduced learning for higher frequency structures and, in turn, weaker priming for these structures and stronger priming for less frequent ones. It is worth noting that both Reitter et al. and Chang et al. predict similar outcomes based on differences in the relative frequencies of syntactic alternants. However, the mechanisms underlying these effects differ: Chang et al.'s account stems from an error-based learning mechanism, while Reitter et al.'s theory is based on the base-level activation of syntactic structures. It is important to emphasize that both Chang et al.'s and Reitter et al.'s accounts are specifically formulated for L1 syntactic processing. To date, only Khoe et al. (2021) have investigated a bilingual version of the implicit learning account. However, it is not clear how the inverse-frequency effect can be explained within this bilingual framework. In their model, both active and passive structures occurred with the same frequency in the training input. This choice was made by the researchers to maximize the likelihood of observing a cross-language structural priming effect. They hypothesized that if a structure, such as an active, is produced very frequently regardless of priming, ceiling effects might make it harder to detect a priming effect. Nonetheless, Khoe et al. speculate that error-based learning, which triggers an inverse-frequency effect, also plays an important role in L2 syntactic learning.

Based on the predictions of Hartsuiker and Bernolet's theory, during L2 syntactic acquisition, priming should be observed earlier for more frequent structures than for less frequent ones. Moreover, the predictions of Hartsuiker and Bernolet's account are based on the abstraction process of similar L2 structures. However, in Chapter 3, we only found passive priming and no active priming. It is difficult to determine whether the absence of active priming was due to the dissimilarity between the active structure in Dutch and the one in Spanish or whether the inverse-frequency effect could have been the driving force behind this observed effect. Similarly, it is challenging to ascertain whether passive priming occurred due to the similarity of the passive structures in Dutch and Spanish or due to inverse-frequency effects. Furthermore, a shortcoming of Hartsuiker and Bernolet's account arises in situations where priming is predicted to occur earlier for frequent syntactic structures that are also the similar alternants. For instance, in Chapter 4, if we were to observe priming *only* for the PP-final passive structure, which is the most commonly occurring passive form in Dutch (without considering the effect of explicit teaching) and is also similar between Dutch and French, it would be challenging to determine whether the priming effects were due to the similarity of this structure to the one in French or simply because it is the most frequent passive form in Dutch. If researchers were to base their predictions on Hartsuiker and Bernolet's account, it is important to be aware of this possible situation. To avoid encountering such a situation, one would need to ensure that the L1-L2 similar structure is the less frequent alternant in the L2. As a result, priming of the L1-L2 similar structure can only be attributed to the similarity of a given structure between the first and second language. In any case, regarding the findings in this project, it seems more likely to assume that our priming patterns were driven by inverse-frequency effects, considering that this effect is robust and widely reported in numerous structural priming studies (Hartsuiker & Kolk, 1998; Hartsuiker et al., 1999; Segaert et al., 2016; Bernolet et al., 2010; McDonough & Fulga, 2015; Wei et al., 2022). The above discussed findings strengthen Hartsuiker and Bernolet's suggestion for incorporating an implicit learning mechanism into their developmental account.

As discussed earlier, Hartsuiker and Bernolet's theory on L2 syntactic acquisition is based on lexicalist frameworks (e.g., Hartsuiker et al., 2004; Pickering & Branigan, 1998). Consequently, lexical boost effects are predicted to decay rapidly within these frameworks. Hence, the long-lasting lexical boost effect observed in Chapter 2 and 3 as a result of our intervention block cannot be explained within a lexicalist account. Chang et al. (2006) do not predict increased structural priming due to lexical repetition between the prime and target. In other words, one would still expect to find priming for the alternant that occurs less frequently in the input, regardless of lexical overlap. Instead, they propose that the lexical boost effect occurs due to explicit memory of the prime structure. When planning a target sentence, the repeated lexical item serves as a cue for the memory of the prime sentence, prompting speakers to reproduce its structure in formulating the target sentence. It is important to note that Chang et al. differentiate the explicit memory component of priming from their model's weight-changes mechanism. In contrast to Chang et al., Reitter et al. (2011) incorporate the lexical boost effect into their multifactorial account. According to their model, lexical boost effects in structural priming result from the spread of lexical activation from working memory to long-term memory. Consequently, during production, the lexical information stored in working memory serves as a cue for retrieving syntactic information, explaining lexical enhancements observed in structural priming. Importantly, Reitter and colleagues predict that the lexical boost can occur with any type of lexical overlap between the prime and target. Furthermore, Reitter et al.'s account also predicts cumulative priming effects (note that cumulative priming effects cannot be explained within lexicalist frameworks), which may explain why the strength of passive priming increased after the intervention compared to before the intervention (Chapter 3). However, it is important to note that Reitter et al.'s model has not yet been extended to bilinguals. Consequently, it becomes challenging to explain our findings regarding the long-lasting lexical boost effects using Reitter et al.'s model. Developing a bilingual version of Reitter et al.'s model would allow us to provide a better explanation for the effects of a lexically-based intervention block on abstract structural priming in subsequent trials, as observed in Chapters 2 and 3.

Another crucial finding from this project is that L2 syntactic production preferences are *dynamic*, as they appear to be influenced by (explicit) learning, as observed in Chapter 4 and 5. Furthermore, production preferences can shift as a result of short-term increased exposure to a specific structure within an experiment, as discussed in Chapter 5. Changes in structural preferences can be explained by implicit learning (Chang et al., 2006; Reitter et al., 2011). Both the accounts of Chang et al. and Reitter et al. are sensitive to the relative frequency with which syntactic structures are used. According to Chang et al., repeated usage of a specific structure strengthens the weights of that structure, thereby increasing the likelihood of its usage. Additionally, the authors propose that the weight changes to a particular structure are permanent. Based on these predictions, one can argue that due to explicit language teaching in favor of the PP-medial passive structure during classes (Chapter 4), participants showed a strong preference to spontaneously use this structure in the baseline condition. This can be attributed to the stronger establishment of the weights of the syntactic representation of the PP-medial passive form in memory, compared to the representation of the PP-final passive structure. Here, however, there seems to be an interplay between explicit learning of syntactic rules, and implicit learning processes, as participants implicitly tuned their expectations of a Dutch passive form to the PP-medial passive structure. Moreover, according to Reitter et al., one can argue that the explicit teaching of the PP-medial passive over the PP-final passive led to an increased base-level activation of the former structure. This higher base-level activation prompted participants in Chapter 4 to choose to produce the PP-medial passive over the PP-final passive structure in the baseline condition. Additionally, one may hypothesize that L2 syntactic production preferences can easily shift (as observed in Chapter 5) because, unlike L1 syntactic structures, L2 structures are not yet deeply entrenched in the memory of L2 learners. Consequently, L2 syntactic structures are more susceptible to changes in biases compared to implicitly learned L1 biases. While it is highly likely that error-based learning and/or base-level activation of syntactic structures play a role in the dynamic nature of L2 structural preferences, further investigation using bilingual computational models is necessary to determine the extent to which these mechanisms can account for changes in L2 structural preferences. Khoe et al.’s (2021) findings do not shed light on this since the language input for their computational model did not contain structural preference (by means of a higher frequency input) towards one syntactic alternant over another.

Overall, based on the discussion in the previous paragraphs, it is reasonable to suggest that the current developmental account of Hartsuiker and Bernolet's shows some shortcomings (also discussed in Muylle, 2020a; Van Lieburg, 2023). In fact, the account can benefit from the following suggestions: (1) including a mechanism that predicts an inverse-frequency effect, which is now only predicted within the implicit learning framework (in accordance with Muylle, 2020a; Van Lieburg, 2023), (2) elaborating on whether the relative frequency of syntactic alternants or the L1-L2 syntactic similarity plays a more significant role in the occurrence of structural priming, (3) accounting for the presence of (long-lasting) lexical boost effects (see also Muylle, 2020a), and (4) importantly, accounting for the finding that L2 structural preferences are subject to explicit teaching/learning, which may result in a priming pattern that is not dependent on L1-L2 syntactic similarity. These limitations suggest that it is worthwhile to extend bilingual computational models, such as the one proposed in Khoe et al., while also considering the findings from the work by Reitter et al.

Conclusions and Future Directions

All findings considered, there is some support for Hartsuiker and Bernolet's developmental account of L2 syntactic acquisition. Specifically, active priming was observed before passive priming. Additionally, lower proficiency learners benefit from lexical repetition between prime and target sentences as they depend on item-specific representations compared to higher proficiency learners. Furthermore, L2 proficiency plays a crucial role in the abstraction process of L2 syntactic structures, particularly in the formation of syntactic representations for infrequent, dissimilar, or less preferred L2 syntactic structures.

Despite the theory's limitations, such as not accounting for inverse-frequency effects, (long-lasting) lexical boost effects, effects of explicit teaching, and the simultaneous influence of relative frequency *and* L1-L2 syntactic similarity, it remains valuable to test its predictions, taking into account the suggestions provided in the previous section. This is because my project was unable to examine the account's key predictions under optimal conditions due to the impact of the Covid-19 pandemic. Our longitudinal study yielded promising results, as learners demonstrated active priming, which is almost never found, particularly when a baseline is used. However, considering that learning effects emerged as an important factor that impeded our investigation of when and how participants formed a representation for the passive structure, future studies could incorporate different syntactic alternants in their primes, such as including ditransitives, to account for a potential learning effect. Additionally, researchers could adopt Favier et al.'s (2019) testing method, which involved testing participant in a classroom context using Microsoft PowerPoint Presentation and answer booklets. This testing method enables researchers to test all learners simultaneously, for instance, during regular classroom hours. By implementing this approach, participants may feel more motivated to engage in the study. However, this testing method also has its drawbacks. Participants may lose their attention without the researcher noticing, which may lead to an increased number of "other" responses. Furthermore, such a method requires the recruitment of research assistants to ensure the smooth execution of the study. Additionally, establishing a strong collaboration with language teachers is crucial, as it requires their valuable time. Nevertheless, testing within a classroom context provides the closest approximation to an actual L2 learning situation.

Although we did not consider the effects of explicit teaching in our research design, the effects of explicit instruction turned out to be an important predictor for structural preferences and structural priming of syntactic alternants. For this reason, I suggest that it is fruitful to collaborate (more) intensely with L2 teachers. For instance, psycholinguists may involve L2 teachers in their research to better investigate the effects of the proposed intervention methods in this dissertation. Ideally, a strong collaboration between psycholinguists and L2 teachers will enable researchers to formulate more precise (and perhaps more pedagogically relevant) research questions, thereby increasing our understanding of how second language learners acquire L2 syntax.

NEDERLANDSE SAMENVATTING

Tijdens het leren van een tweede taal (T2) kunnen late leerders soms gebruik maken van de syntactische informatie uit hun eerste taal (T1) om gelijkaardige syntactische structuren in hun tweede taal te produceren. Engelssprekende leerders van het Nederlands kunnen bijvoorbeeld hun T1 gebruiken om een passieve zin in het Nederlands te vormen omdat deze structuur gelijkaardig is in beide talen (bijvoorbeeld, *The boy is being kissed by the girl* – De jongen wordt gekust door het meisje). In dit geval wordt de handelde persoon aangegeven met een *door*-bepaling aan het einde van de zin. De T2 kan echter ook syntactische structuren hebben die niet voorkomen in de T1 van leerders. In tegenstelling tot het Engels biedt het Nederlands een alternatieve manier om de passieve vorm uit te drukken. Men kan namelijk ook zeggen “De jongen wordt door het meisje gekust” (**The boy is by the girl being kissed*). In dit geval staat de *door*-bepaling in het midden van de zin. Bij het tegenkomen van deze ongelijke T2 syntactische structuren in de vroege stadia van het verwerven van T2 syntaxis kunnen leerders dus niet gebruik maken van syntactische informatie uit hun T1 omdat hun eerste taal geen gelijkaardige structuur heeft. Daarom moeten leerders nieuwe structurele representaties ontwikkelen voor deze ongelijke T2-structuren (Hartsuiker & Bernolet, 2017). Maar hoe gebeurt dit?

In dit proefschrift testte ik de predicties van Hartsuiker en Bernolet’s (2017) ontwikkelingsmodel van de verwerving van T2 syntaxis door middel van *structurele priming* (Bock, 1986). Structurele priming verwijst naar het fenomeen waarbij sprekers de neiging hebben om recentelijk ervaren syntactische structuren over te nemen in hun eigen producties. In hun model stellen Hartsuiker en Bernolet dat bij het verwerven van T2 syntaxis, late tweedetaalleerders aanvankelijk item-specifieke T2 representaties ontwikkelen, die zich dan ontwikkelen tot abstracte syntactische representaties. Na verloop van tijd worden deze abstracte T2 syntactische representaties gedeeld met bestaande T1 syntactische representaties, wanneer de T1-T2 syntactische structuren voldoende overeenkomsten vertonen. Om nog eens hetzelfde voorbeeld te gebruiken: het Nederlandse passief (De jongen wordt gekust door het meisje) en het Engelse passief *(The boy is being kissed by the girl)* hebben een gelijkaardige syntactische structuur, en Hartsuiker en Bernolet veronderstellen daardoor dat tweetaligen een gedeelde mentale representatie hebben voor gelijkaardige structuren tussen talen in plaats van gescheiden representaties. De aanname dat tweetaligen gedeelde representaties hebben voor gelijkaardige T1-T2 structuren is al aangetoond in verschillende studies (zie bijvoorbeeld, Hartsuiker et al., 2004; Shin & Christianson, 2009, en Bernolet et al., 2013) Hartsuiker en Bernolet stellen ook dat het proces van abstractie wordt beïnvloed door de frequentie van T2 syntactische structuren en het beheersingsniveau van de tweede taal. Bovendien worden abstracte syntactische representaties eerder gevormd voor vaak voorkomende structuren, zoals actieve zinnen, in vergelijking met minder frequente structuren zoals passieven. Verder stellen Hartsuiker en Bernolet dat gevorderde tweetaligen abstracte structurele priming binnen en tussen talen zullen vertonen, terwijl minder gevorderde tweetaligen waarschijnlijk alleen binnen-T2 priming zullen vertonen wanneer er lexicale overlap is tussen prime- en targetzinnen.

In Hoofdstuk 2 hebben we gebruikgemaakt van twee verschillende onderzoeksdesigns, namelijk een longitudinaal en een cross-sectioneel design, om te onderzoeken of en wanneer een diverse groep late leerders van het Nederlands priming zou vertonen voor actieve en passieve zinnen tijdens hun leertraject (Muylle, 2021a, gebruikte een kunstmatige taal om een gelijkaardige vraag te onderzoeken). Daarnaast hebben we onderzocht of een interventie met lexicale overlap de verwerving van de passieve structuur kon versnellen. Deze interventie is met name relevant voor beginnende tweedetaalleerders, omdat er gebleken is dat deze leerders sterk afhankelijk zijn van lexicale overlap om structurele priming mogelijk te maken (Bernolet et al., 2013; Hartsuiker & Bernolet, 2017).

Zoals verwacht zagen we dat actieve priming eerder optrad dan passieve priming, gezien de hogere frequentie van actieve zinnen in natuurlijke taal. We vonden echter ook dat abstracte representaties van de passieve structuur snel werden gevormd na blootstelling aan deze structuur, en dat onze interventie dit proces leek te vergemakkelijken.

In Hoofdstuk 3 onderzocht ik een scenario waarin tweedetaalleerders te maken krijgen met een morfosyntactisch ongelijke, maar frequente T2-syntactische structuur, en met een gelijkaardige, maar minder frequente T2-syntactische structuur. De reden om dit te onderzoeken is omdat Hartsuiker en Bernolet's theorie geen voorspellingen maakt over de volgorde waarin deze syntactische alternanties geleerd worden. Met behulp van een tussen-taal-priming experiment met beginnende leerders van het Spaans met T1 Nederlands, onderzocht ik in hoeverre deze leerders priming zouden vertonen voor actieve en passieve structuren. Ook onderzocht ik of een interventie met lexicale overlap tussen prime- en targetzinnen de productie van beide transitieve structuren zou stimuleren in de zinnen die volgen zonder lexicale overlap. In het Spaans verschilt de actieve structuur, die de frequentste transitieve vorm is, in zijn morfosyntactische realisatie van die in het Nederlands ("*La chica saluda al chico*" – "*Het meisje groet de jongen*"). Hier wordt de patiëns (de jongen) voorafgegaan door de lijdendvoorwerpmarkering "al", die overeenkomt met het geslacht van de patiëns. Het Nederlands kent zo'n lijdendvoorwerpmarkering niet. De passieve structuur, de minder frequente transitieve vorm, is vergelijkbaar in beide talen ("*El chico es saludado por la chica*"- "*De jongen wordt gegroet door het meisje"*). We vonden passieve priming ongeacht de primetaal (m.a.w., er was geen verschil tussen T2-priming en T1-T2 priming); en de interventie zorgde voor een verhoogde productie van passieve zinnen in de opeenvolgende trials zonder lexicale overlap. Hoewel we geen actieve priming vonden, produceerden gevorderde tweetaligen vaker de morfosyntactisch ongelijke Spaanse actieve structuur (hoewel ze dit niet altijd correct deden) in vergelijking met minder gevorderde tweetaligen.

Onze interventie bleek ook het gebruik van de ongelijke T2 actieve structuur te verbeteren. Deelnemers produceerden namelijk vaker de correcte actieve vorm na de interventie dan voor de interventie. Dit suggereert dat een dergelijke interventie niet alleen de vorming van abstracte structurele representaties bevordert, maar ook het correcte gebruik van ongelijke T2-structuren verbetert.

In Hoofdstuk 4 onderzocht ik een situatie waarin T2-leerders geconfronteerd worden met het leren en produceren van een ongelijke T2 syntactische structuur, terwijl ze de optie hebben om een gelijkaardige T1-T2 syntactisch alternatief te gebruiken dat ze al kennen. Ook onderzocht ik in hoeverre T2-vaardigheid een rol speelt bij het primen van deze ongelijke T2-structuur. Het doel was om de syntactische voorkeuren van T2 leerders te onderzoeken, en hun structurele primingpatroon in dergelijke situaties. Hiervoor gebruikte ik Nederlandse passieven (PP-*final*, *De jongen wordt gekust door het meisje*, en PP-*medial, De jongen wordt door het meisje gekust*) in een structurele priming experiment om te onderzoeken of Frans-Nederlandstaligen priming zouden vertonen voor deze twee structuren. In tegenstelling tot het Nederlands staat het Frans alleen het PP-final passief toe, en het PP-medial passief bestaat niet in deze taal. Mijn experiment liet onverwachts een productievoorkeur zien voor het PP-medial passief. Dit kwam omdat we ontdekten dat de leerders expliciete taallessen kregen waarin hen werd geleerd om het PP-medial passief te gebruiken voor het formuleren van een passief in het Nederlands. Samen met de T2-vaardigheid van de leeerders beïnvloedde dit de productievoorkeuren en structurele priming effecten van de passieven. We observeerden primingeffecten voor zowel PP-final als PP-medial passieven, wat erop wijst dat de leerders representaties hadden ontwikkeld voor zowel de gelijkaardige als de ongelijkaardige T2-passieven. Deelnemers met een lagere taalvaardigheid produceerden vooral PP-medial passieven in de baselineconditie en vertoonden hierdoor sterke PP-final priming, terwijl deelnemers met een hogere taalvaardigheid zowel PP-medial als PP-final passieven produceerden in de baselineconditie, waardoor PP-medial priming kon optreden. Deze bevindingen suggereren dat T2-vaardigheid een belangrijke rol speelt in de priming van zowel gelijkaardige als ongelijkaardige T2 syntactische structuren.

Voortbouwend op de bevindingen in Hoofdstuk 4, waaruit bleek dat Frans-Nederlandstaligen de voorkeur gaven aan het gebruik van het ongelijkaardige PP-medial passief als gevolg van expliciet taalonderwijs, onderzocht ik in Hoofdstuk 5 of het verhogen van het aantal PP-final passieven in de primezinnen zou leiden tot een hogere frequentie van deze structuur tijdens T2 syntactische productie. We vonden inderdaad dat deelnemers meer PP-final passieven produceerden in de baselineconditie door onze frequentiemanipulatie. Bovendien zagen we sterkere PP-medial priming dan PP-final priming. Daarbij was PP-final priming zwakker voor gevorderde tweetaligen dan voor minder gevorderde tweetaligen, omdat het aandeel PP-final passieven in de baselineconditie toenam wanneer de T2 taalvaardigheid ook toenam.

Tot slot heeft het normeringsonderzoek onder Nederlandssprekende kinderen in de leeftijd van 6-12 jaar in Hoofdstuk 6 laten zien dat onze afbeeldingen, die specifiek voor dit project zijn ontwikkeld en in hoofdstukken 2 en 3 zijn gebruikt, ook bruikbaar zijn voor onderzoekers die de verwerving van transitieve structuren bij kinderen willen onderzoeken.

De resultaten van de structurele priming experimenten die in dit project zijn uitgevoerd, leveren enig bewijs voor de predicties van Hartsuiker en Bernolet’s model. We vonden namelijk actieve priming vóór passieve priming, wat suggereert dat priming eerder optreedt bij meer frequente structuren dan bij minder frequente structuren. Bovendien vonden we dat beginnende T2 leerders sterk afhankelijk zijn van item-specifieke representaties, omdat ze nog geen abstracte syntactische representaties hebben ontwikkeld. Ook tonen de data aan dat T2-vaardigheid een belangrijke rol speelt in de ontwikkeling van abstracte T2 representaties voor gelijkaardige en ongelijkaardige T2 structuren.

Er waren echter enkele bevindingen in dit project die niet verklaard kunnen worden enkel op basis van het model van Hartsuiker en Bernolet. De volgende suggesties zouden het model op belangrijke aspecten kunnen verbeteren (sommige van deze suggesties zijn al voorgesteld door de twee auteurs van het model, en zijn ook voorgesteld door Muylle, 2020a en Van Lieburg, 2023): (1) het model verklaart nog niet het optreden van het *inverse-frequency* effect, dat momenteel alleen wordt voorspeld binnen het *implicit learning account* (Chang et al., 2006; Reitter et al., 2011), (2) het model maakt geen predicties over de vraag of de relatieve frequentie van syntactische alternanten of de syntactische gelijkenis tussen T1 en T2 structuren een belangrijkere rol speelt bij het optreden van structurele priming, (3) het model verklaart ook nog niet langdurige *lexicale boost* effecten (zie ook Muylle, 2020a), en (4) het model houdt geen rekening met de impact van het expliciet leren van T2 structuren, wat kan leiden tot een primingpatroon dat niet afhankelijk is van de syntactische gelijkenis tussen T1-T2 structuren. Deze tekortkomingen in het model geven aan dat het noodzakelijk is om tweetalige computationele modellen uit te breiden, zoals het model dat is voorgesteld in de tweetalige versie van het *implicit learning account* van Khoe et al. (2021), en om rekening te houden met inzichten uit Reitter et al. (2011), die een multifactoriëel mechanisme hebben voorgesteld om structurele priming effecten te verklaren.

Concluderend denk ik dat het combineren van theoretische inzichten uit de psycholinguïstiek, zoals gepresenteerd in dit proefschrift, en praktische kennis uit vreemdetalenonderwijs zal leiden tot een beter en grondiger begrip van het proces van T2-syntactische verwerving.

ENGLISH SUMMARY

When learning a second language (L2), learners sometimes rely on the knowledge of their first language (L1) syntax to produce similar syntactic structures in the L2. For instance, English-speaking learners of Dutch may use their L1 to form a passive sentence in Dutch because this structure is similar in both languages (e.g., The boy is being kissed by the girl – *De jongen wordt gekust door het meisje*). In this case, the prepositional by-phrase occurs at the end of the sentence. However, the L2 may also have syntactic structures that are absent in the learner's L1. For example, unlike English, Dutch offers an alternative way to express the passive form: "*De jongen wordt door het meisje gekust*" (*The boy is by the girl being kissed). In this case, the prepositional by-phrase appears in the middle of the sentence. When encountering these dissimilar L2 syntactic structures, L2 learners cannot rely on their L1 knowledge in the early stages of L2 syntactic acquisition because there is no corresponding structure in their L1. Consequently, learners must develop and establish new structural representations for these dissimilar L2 structures (Hartsuiker & Bernolet, 2017). But how does this occur?

In this dissertation, I used *structural priming* to test the predictions of Hartsuiker and Bernolet's developmental account of L2 syntactic acquisition. Structural priming refers to the tendency of language users to repeat syntactic structures they have encountered before (Bock, 1986). In their account, Hartsuiker and Bernolet claim that, during L2 syntactic acquisition, late second language learners start with item-specific L2 representations that evolve into abstract syntactic representations. Over time, these L2 abstract syntactic representations become *shared* with existing L1 syntactic representations, whenever the L1-L2 syntactic structures are sufficiently *similar*. To use the same example again: the Dutch passive (*De jongen wordt gekust door het meisje*) and the English passive (The boy is being kissed by the girl) have a similar syntactic structure, and Hartsuiker and Bernolet propose that bilinguals

therefore have a shared mental representation for these structures across languages rather than separate representations. The assumption that bilinguals have shared representations for similar L1-L2 structures has already been demonstrated in several studies (see, for example, Hartsuiker et al., 2004; Shin & Christianson, 2009, and Bernolet et al., 2013). Hartsuiker and Bernolet also propose that the process of abstraction is influenced by the frequency of L2 syntactic structures and the proficiency level in the second language. Moreover, abstract syntactic representations are expected to be formed earlier for frequently occurring structures, such as active sentences, compared to less frequent structures like passives. Furthermore, advanced bilinguals are anticipated to demonstrate abstract L2 structural priming and cross-language structural priming, whereas less advanced bilinguals are likely to show within-L2 priming only in conditions involving lexical overlap.

Using two different designs in Chapter 2, namely, a longitudinal and a cross-sectional design, we tested whether and when a diverse group of late learners of Dutch would show priming for active and passive sentences during their learning trajectory (Muylle, 2021a, used an artificial language to address this question). We also investigated whether a lexically-based intervention could accelerate the learning of the passive structure. This intervention is particularly relevant for beginning L2 learners, as they are believed to rely heavily on lexical overlap for structural priming to take place (Bernolet et al., 2013; Hartsuiker & Bernolet, 2017). As anticipated, we observed that active priming occurred before passive priming, given the higher frequency of active sentences in natural language. However, we found that abstract representations of the passive structure were formed rapidly after exposure, and that our lexically based intervention seemed to facilitate this process.

In Chapter 3, I investigated a scenario in which second language learners encounter a morphosyntactically dissimilar, yet highly frequent, L2 syntactic structure, as well as a similar, but less frequent, L2 syntactic structure. The reason for exploring this scenario is that the developmental account does not make predictions about the order in which these syntactic alternations are acquired. Using a cross-language priming experiment with beginning learners of Spanish with L1 Dutch, I investigated to what extent these learners would show priming for active and passive structures, and whether a lexically-based intervention would boost the production of both transitive structures in subsequent trials without lexical overlap. In Spanish, the active structure, which is the most common transitive form, differs in its morphosyntactic realization from the one in Dutch ("*La chica saluda al chico*" – "*Het meisje groet de jongen*" [The girl greets the boy]). Here, the patient (the boy) is preceded by the direct object marker "al", which agrees with the patient's gender. Dutch does not have such a direct object marker. On the other hand, the passive structure, the less frequent form, is similar in both languages ("*El chico es saludado por la chica*" – "*De jongen wordt gegroet door het meisje*" [The boy is being greeted by the girl]). We found passive priming regardless of the prime language; and the intervention enhanced passive production in subsequent trials without verb overlap. Although we did not observe active priming, advanced bilinguals were more likely to produce the morphosyntactically dissimilar Spanish active structure (although not always correctly) compared to less advanced bilinguals. Interestingly, our lexically-based intervention facilitated the correct usage of the dissimilar L2 active structure. This suggests that such an intervention does not only promote the formation of abstract structural representations but also improves the accurate usage of dissimilar L2 structures.

In Chapter 4, I explored a situation where L2 learners are faced with learning and producing a dissimilar L2 syntactic structure when they have the option to use a similar L1-L2 syntactic alternative that is already familiar to them. Also, I examined to what extent L2 proficiency plays a role in the priming of these dissimilar L2 structures. The goal was to investigate L2 learners' preferences and their structural priming pattern in such situations. For this, I investigated the priming of Dutch (PP-final and PP-medial) passives in a within-structural priming experiment involving French-Dutch bilinguals. In contrast to Dutch, French only allows the PP-final passive, and the PP-medial passive does not exist in this language. Surprisingly, our experiment revealed a production preference for the PP-*medial* passive structure. We discovered that the learners had been *explicitly* taught to use the PP-medial passive structure, which, along with their L2 proficiency, influenced their production biases and structural priming. We observed priming effects for both PP-final and PP-medial passives, indicating that the learners had established representations for both the similar and dissimilar L2 structures. Lower proficiency speakers mostly produced PP-medial passives in the baseline condition and therefore showed strong PP-final priming, whereas higher proficiency L2 speakers produced both PP-medial and PP-final passives in the baseline condition, allowing PP-medial priming to occur. These findings suggest that L2 proficiency plays an important role in the priming of both similar and dissimilar L2 syntactic structures.

Building on the findings in Chapter 4, which revealed that French-speaking learners of Dutch preferred using the dissimilar PP-medial passives due to explicit language teaching, Chapter 5 aimed to examine whether increasing the proportion of PP-final passive primes would lead to a higher frequency of PP-final passives during L2 syntactic production. Indeed, we found that learners produced more PP-final passives in the baseline condition. Moreover, we observed stronger PP-medial priming than PP-final priming. Furthermore, PP-final priming was weaker for advanced bilinguals than for less advanced bilinguals, because the proportion of PP-final passives in the baseline condition increased together with participants' L2 proficiency.

Finally, the norming study among Dutch children aged 6-12 years in Chapter 6 showed that our picture set, which was specifically developed for this project and used in Chapters 2 and 3, is also useful to researchers who intend to investigate the acquisition of transitive structures in children.

The results of the structural priming experiments conducted in this project provide some evidence supporting the predictions of Hartsuiker and Bernolet's developmental account of L2 syntactic acquisition. Namely, we observed active priming before passive priming, which suggests that priming occurs earlier for more frequent structures compared to less frequent ones. Moreover, we found that beginning L2 learners heavily depend on item-specific representations, as they have not yet developed abstract syntactic representations. In addition, our data support the assumption that L2 proficiency plays an important role in the development of abstract L2 representations for similar and dissimilar structures.

However, there were several findings in this project that challenge the account of Hartsuiker and Bernolet. To improve the account, the account could benefit from the following suggestions (some of these suggestions have already been proposed by the authors of the developmental model, and have been also suggested by Muylle, 2020a and Van Lieburg, 2023): (1) incorporating a mechanism that predicts an inverse-frequency effect, which is currently only accounted for within the framework of implicit learning (Chang et al., 2006; Reitter et al., 2011), (2) elaborating on whether the relative frequency of syntactic alternants or L1-L2 syntactic similarity plays a more important role in the occurrence of structural priming, (3) addressing the presence of long-lasting lexical boost effects (see also Muylle, 2020a), and (4) crucially, considering the impact of explicit teaching/learning on L2 structural preferences, which may lead to a priming pattern that does not rely on L1-L2 syntactic similarity. These limitations indicate the need to extend bilingual computational models, such as the one proposed in the bilingual version of the implicit learning account by Khoe et al. (2021), and to take into account insights from Reitter et al. (2011), who proposed a multi-factorial account to explain structural priming effects.

In conclusion, I believe that combining theoretical insights from psycholinguistics, as presented in this dissertation, and practical knowledge from foreign language teaching, will allow for a better and more thorough understanding of the process of L2 syntactic acquisition.

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APPENDICES

Appendix S1. Additional Information on the Participants' Section: Choice in Sample Size and Learners' Background.

<u>Our choice for the sample size for each language group:</u>

According to Mahowald et al. (2016), a statistical power of 80% is a standard threshold for experiments. Based on a meta-analysis of 45 structural priming studies in language production, they give recommendations on the number of items and participants that are necessary for a structural priming experiment, with or without lexical overlap (see Figure 11 in their paper). Our within-language priming experiment did not have lexical overlap. We had 36 experimental items (12 baseline items, 12 PP-final primes and 12 PP-medial primes). We used Figure 11 and 12 in Mahowald et al. as a guide to determine how many participants we had to recruit per language group, while keeping our main predictors (*Prime Condition* and *L2 Proficiency*) in mind.

- Dutch native speakers: 48 participants

  To comfortably achieve a threshold of 80% power for the experiment involving native speakers, Mahowald et al. (as displayed in Figure 11 in their paper), recommend using at least 48 subjects in an experiment with 36 experimental items that do not have lexical overlap. For this reason, we aimed to recruit 48 participants for our control group. Furthermore, we believed 48 participants would be sufficient since we only had one main factor (*Prime Condition*) that could affect the target responses produced by the native speakers.

- French-Dutch bilinguals: 96 participants

  In their paper, Mahowald et al. (2016) also propose sample size recommendations to detect a moderator of priming. In our case, we were interested in an interaction between *Prime Condition* and *L2 Proficiency* in the data for the late L2 learners. In Figure 12, Mahowald et al. suggest three different interaction sizes: .2, .5 and 1, with a coefficient of 1 being similar to representing the size of a lexical overlap effect. Because we expected that the effect of *L2 Proficiency* was probably going to be less strong than the effect of lexical overlap, we chose not to estimate our number of subjects based on a coefficient of 1. A coefficient of .2, on the other and, suggests a small interaction. To be on the safer side, we estimated the size of the effect of *L2 proficiency* on *Prime Condition* to be somewhere between .2 and 1. For this reason, we decided to consider the sample size recommendations for the coefficient .5. In terms of how feasible it was to recruit enough learners of Dutch with L1 French, we decided that we had to recruit at least 96 participants, as this would lead to an estimated power of 0.44 – 0.67. According to Figure 12, recruiting 128 participants would result in more power (between 0.58 – 0.86), but recruiting that many subjects was not feasible in the current study.

Additional features on the L2 learners' background.

In the LEAPQ questionnaire, we asked participants to indicate whether they had received formal Dutch language instruction (i.e., through Dutch language courses, immersion schools, during an exchange program etc.) and in what contexts they spoke Dutch.

We had 96 French-Dutch bilinguals, 8 participants indicated that they had learned Dutch in immersion schools, 67 participants learned Dutch through language courses and there were 21 participants who did not specify how they had learned Dutch. In terms of the context in which these 92 participants used Dutch, 64 participants reported that they used Dutch outside a school context (i.e., with friends, at work, during their Erasmus exchange program, and with family members, mostly from Flanders, Belgium), while 32 participants indicated that they solely used Dutch in a school context (i.e., only during Dutch language classes).

Though these are descriptive features of our learners' data, it seems that most of the learners learned Dutch in language courses (thus implying that they probably received explicit language instruction on the formulation of the Dutch passive (i.e., the PP-medial passive)) and that most of the learners used Dutch outside a school context.

Appendix S2. Analysis on the Data of the Native Dutch Speakers.

The native speakers (44 participants) produced a total of 1,370 target responses in the experimental block. Of these responses, 1,224 (89.3%) were PP-final passives and 146 (10.7%) responses were PP-medial passives.

Our full model for the native speakers consisted of an interaction between *Prime Condition* * *LexTale*; and the maximal random effects structure consisted of *Prime Condition* as a random slope within *participant*, and *Prime Condition* and *LexTale* as random slopes within-*item*. Since *LexTale* is a continuous covariate, this variable was scaled and centered to its mean. Note that we did not use the term “Proficiency” to denote the LexTale score for the native speakers. We used the term “LexTale” instead because it was developed to test the proficiency of *second language learners* and not native speakers. However, we included this variable in the native speakers’ analysis to analyze the data of the native speakers in the same way as those of the French-Dutch bilinguals.

The final model consisted of an interaction between *Prime Condition* * *LexTale* and random intercepts for *participant* and *item* (see Table 1.S2). In the baseline condition, the native speakers produced more PP-final passives than PP-medial passives. The native speakers showed a significant PP-medial priming effect (b = 1.31, 95% CI [0.75, 1.86], p = .001) but no PP-final priming (b = -0.19, 95% CI [-0.80, 0.42], p = .541). There was no main effect of *LexTale* (b = -0.10, 95% CI [-0.97, 0.76], p = .814) in the baseline condition. We did not find an interaction between PP-final priming and *LexTale* (b = 0.46, 95% CI [-0.22, 1.14], p = .183). Moreover, there was no interaction between PP-medial priming and *LexTale* (b = 0.57, 95% CI [-0.02, 1.15], p = .057). Note that although the latter interaction was not significant, the beta-estimate suggests that PP-medial priming was not the same across all LexTale scores: native speakers who scored very high on the LexTale language test seemed to show stronger PP-medial priming than native speakers with a lower LexTale score.

Table 1.S2 Best fit model for the Native Speakers (N = 1370; log-likelihood = -295.2)

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	-4.60	0.51	-8.85	<.001
Prime Condition PP-final	-0.19	0.31	-0.61	.541
Prime Condition PP-medial	1.31	0.28	4.63	<.001
LexTale	-0.10	0.44	-0.23	.813
Prime Condition PP-final * LexTale	0.46	0.35	1.33	.183
Prime Condition PP-medial * LexTale	0.56	0.30	1.90	.057

Note. Final model = glmer(target response ~ Prime Condition * LexTale + (1|Participant) + (1|Item), data = Dutch, family = binomial)

Given the beta estimates, only the effect size of PP-medial priming was medium; the rest of the effect sizes were very small (see Chen et al., 2010). The random effects of the final model explained 69% of the variance (conditional R^2 = .69, substantial effect; Cohen, 1988) and the fixed effects part explained 5% of the variance (marginal R^2 = 0.06, small effect; Cohen, 1988).

When we checked for violations of assumptions and influential participants, we found a violation of homogeneity of variance in our *Prime Condition.* We discovered that this violation was due to participant 131. Participant 131 also showed a high Cook’s distance, which became evident from the joint analysis (see Appendix S3).

Appendix S3. Joint Analysis: Regression Model without Participant 131.

We reran the final model of the joint analysis without participant 131, who was a native speaker (see Table 2.S3 below). Importantly, in priming studies, priming effects are investigated on a group level. Structural priming studies, as far as we know, do not investigate influential participants by means of the Cook's distance. However, we deemed it important to report this as the Cook's distance shows that individual difference can have a large effect on the estimated coefficients of a regression model and the interpretation of the results (see Figure 1.S3 below). However, it also important to stress that the Cook's distance is not a test statistic and should not by itself be used to accept or reject participants (see Cook, 2011). For this reason, we report the joint analysis with all participants in the manuscript, as this is in line with analyses conducted in conventional structural priming studies. The analysis reported in this appendix is merely to elaborate on individual differences between participants.

Table 2.S3 Best Fit Model for the Joint Analysis excluding Participant 131 (*N* = 3471; log-likelihood = -1157.5

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	-4.87	0.53	-9.06	<.001
Prime Condition PP-final	0.02	0.32	0.07	.582
Prime Condition PP-medial	1.51	0.29	5.21	<.001
GroupL2learners	5.64	0.63	8.84	<.001
Prime Condition PP-final * GroupL2learners	0.76	0.35	-2.15	**.031**
Prime Condition PP-medial * GroupL2learners	-0.99	0.33	-3.01	**.002**

Note. Final model = glmer(target response ~ Prime Condition * Group + (1|Participant) + (1|Item), data = DutchFrench, family = binomial)

Without participant 131 we observed a significant interaction between PP-final passive priming and *Group* (*b* = -0.76, 95% CI [-1.44, -0.07], *p* = .031), which entails that the L2 learners showed stronger PP-final passive priming than the native speakers. Moreover, the interaction between PP-medial passive priming and *Group* became weaker for the L2 learners compared to the native speakers (*b* = -0.99, 95% CI [-1.64, -0.35], *p* = .002).

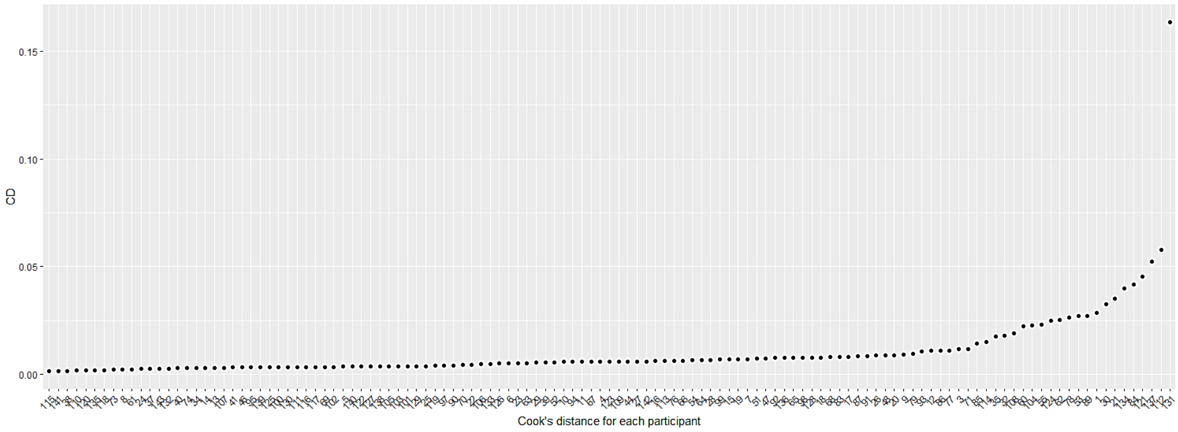


Figure 1.S3 Cook's distance for each participant for the joint analysis. The highest data point (top right) indicates participant 131, and on the x-axis indicates the Cook's distance. Note: Due to the many participants on the x-axis, this figure needs to be enlarged to clearly see the participant numbers.

Upon further investigation into participant 131, we found that they showed very strong PP-*final* passive priming (more PP-final passives after a PP-passive final prime than after the baseline) in comparison to the rest of the native speakers (see Figure 2.S3 below). Participant 131 had a PP-final passive priming effect of 32.32%. We believe that this explains why participant 131 is an outlier from the rest of the native speakers, who displayed strong PP-*medial* passive priming (with an increasing LexTale score, see Figure 3.S3). In other words, participant 131 showed a similar priming pattern as the L2 learners: in the baseline condition, participant 131 had a production preference for the PP-medial passive and this resulted in strong PP-final priming in the PP-final prime condition. Without participant 131, the interaction between PP-final priming and *Group* became significant and the interaction between PP-medial priming and *Group* became stronger (see Table 2.S3).

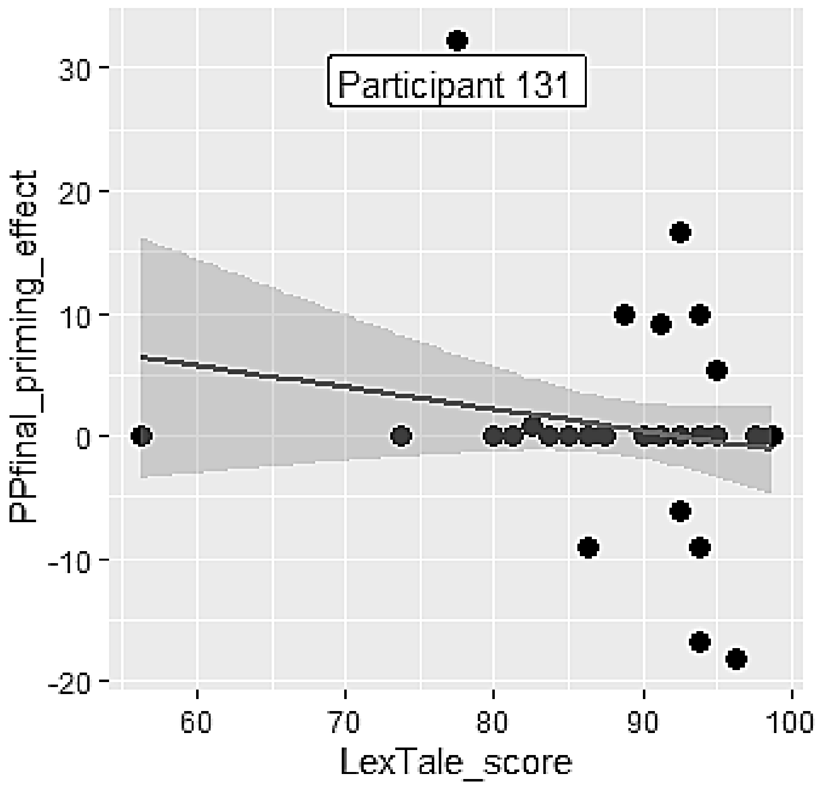


Figure 2.S3. PP-final passive priming effect as a function of the LexTale score for the native speakers. The grey line indicates the decreasing PP-final passive priming effect with increasing LexTale scores. A negative priming effect indicates more PP-final passives in the baseline condition compared to PP-final passives in the PP-final passive prime condition. A positive priming effect indicates more PP-final passives in the PP-final passive prime condition compared to PP-final passives in the baseline condition. Participant 131 shows a large positive PP-final passive priming effect of 32.32%.

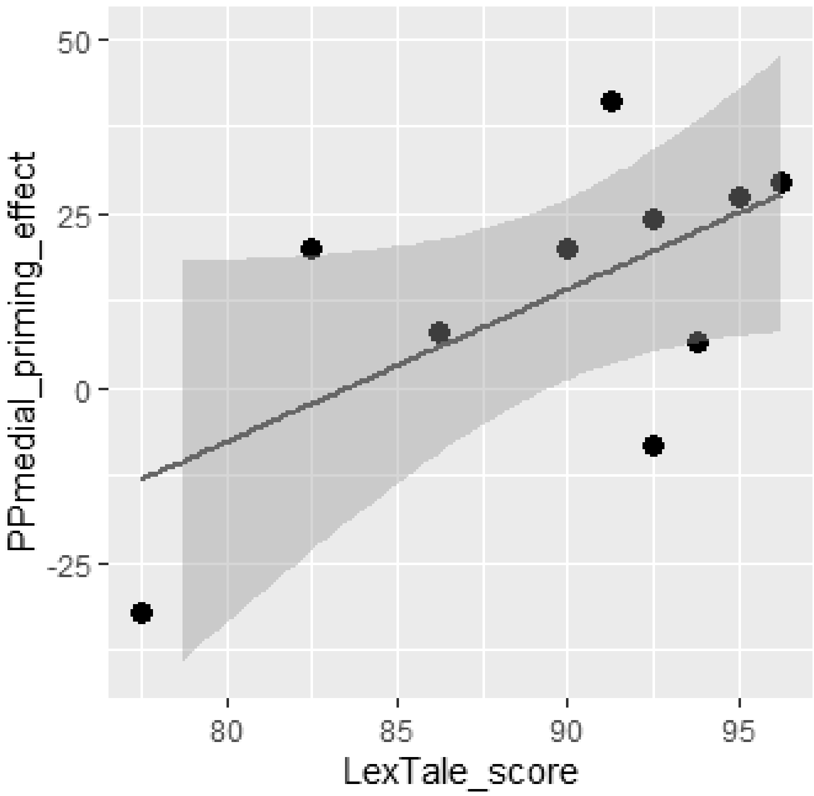


Figure 3.S3. PP-medial passive priming effect as a function of the LexTale score for the native speakers. The grey line indicates the increasing PP-medial passive priming effect with increasing LexTale scores. A negative priming effect indicates more PP-medial passives in the baseline condition compared to PP-medial passives in the PP-medial passive prime condition. A positive priming effect indicates more PP-final passives in the PP-final passive prime condition compared to PP-medial passives in the baseline condition. Note that this figure has fewer data points than Figure 2.S3. This is because there were fewer native speakers who produced PP-medial passives throughout the experiment, nor in the baseline condition, nor in the PP-medial priming condition (in Figure 2.S3, all participants produced a PP-final passive in the baseline condition *and* in the PP-final priming condition). For this reason, the PP-medial priming effect is only due to a few participants, resulting in fewer data points.

Appendix S4. L2 Learners' Analysis: Regression Model without Participant 30.

In the analysis of the L2 learners, participant 30 had a very high LexTALE score (93.75) and showed a very strong PP-medial priming effect of 41.67% (see Figure 4.S4).

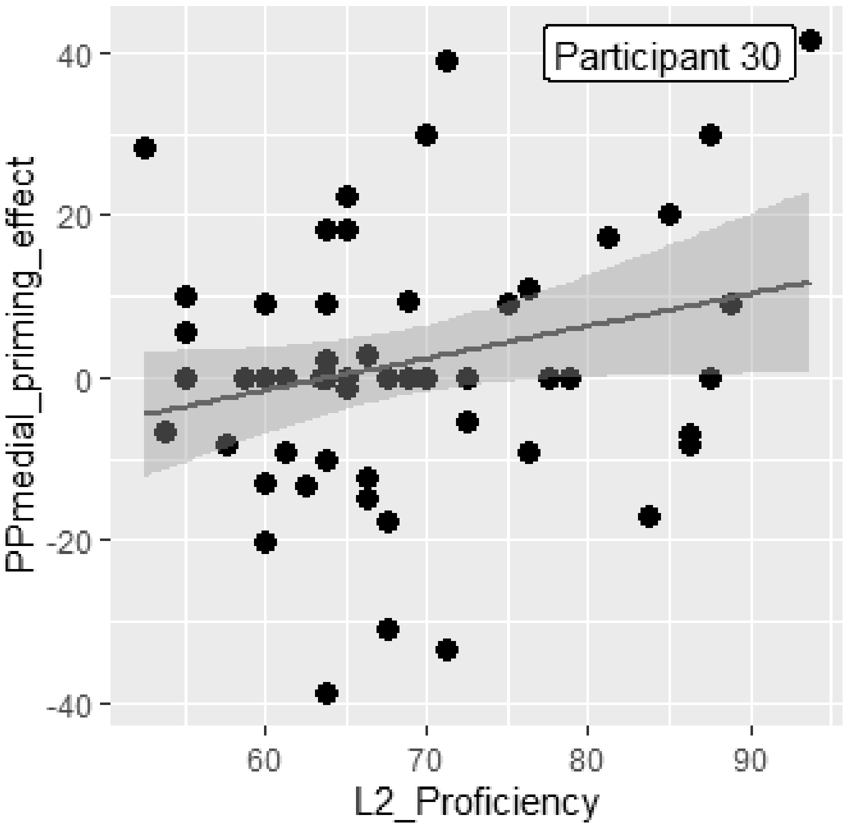


Figure 4.S4 PP-medial passive priming effect as a function of L2 proficiency in the L2 learners. The grey line indicates the increasing PP-medial passive priming effect with increasing L2 proficiency. A negative priming effect indicates more PP-medial passives in the baseline condition compared to PP-medial passives in the PP-medial passive prime condition. A positive priming effect indicates more PP-final passives in the PP-final passive prime condition compared to PP-medial passives in the baseline condition. Participant 30 shows a high L2 proficiency (93.75) and a strong PP-medial passive priming effect.

We reran the final model of the L2 leaners' data without participant 30 and observed that the interaction between *PP-medial priming* * *L2 Proficiency* was no longer significant (*b* = 0.30, 95% CI [-0.04, 0.63], *p* = .084, see Table 3.S4), but there was rather a trend towards significance.

Table 3.S4 Best Fit Model for L2 Learners' data excluding Participant 30 (*N* = 2095; log-likelihood = -858.2

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	0.79	0.37	2.13	**.032**
Prime Condition PP-final	-0.73	0.15	-4.66	<.001
Prime Condition PP-medial	0.43	0.16	2.67	**.007**
L2_proficiency	-0.87	0.38	-2.28	**.022**
Prime Condition PP-final * L2_proficiency	0.28	0.16	1.66	.095
Prime Condition PP-medial * L2_proficiency	0.30	0.17	1.72	.084

Note. Final model = glmer(target response ~ Prime Condition * L2_Proficiency + (1|Participant) + (1|Item), data = French, family = binomial)

It turned out that participant 30 showed the same production preference as the native Dutch speakers: in the baseline condition, they had a strong PP-final passive production bias, which resulted in a very strong PP-medial priming effect. It is possible that participant 30 carried a substantial part of the significant interaction between PP-medial priming and L2 proficiency (see Table 3 in manuscript). However, there remains a trend towards a significant interaction between these two variables, which still suggests that L2 proficiency may moderate the priming of dissimilar L2 structures.

Appendix S5. Cumulative Priming and Self-priming in the L2 Learners' Data

To account for learning effects during the experiment, we explored possible effects of cumulative priming and self-priming for both passive forms. We measured cumulative priming by calculating the number of PP-medial passives and the number of PP-final passives comprehended previously by the participant (i.e., primes) and adding this information as a continuous covariate to the analyses. Moreover, we measured self-priming by adding the number of PP-medial passives and the number of PP-final passives produced by the participants themselves (i.e., their target production). This method is more precise than adding the trial number to the analyses to measure cumulative and self-priming during the experiment, as the PP-medial and PP-final primes did not alternate during the experiment (e.g., 2 PP-medial passives could be followed by 3 PP-final passives) (see Bernolet et al., 2013, who applied the same approach).

Cumulative priming for PP-*medial* passives

There was no significant main effect of PP-medial *cumulative* priming (b = 0.01, 95% CI -0.05, 0.07], p=.680) (see Table 4.S5). This means that participants did not produce more PP-medial passives in the baseline condition upon comprehending more PP-medial prime sentences in the previous trials.

Table 4.S5 Cumulative PP-medial Passive Priming in the L2 Learners Data (*N* = 2130; log-likelihood = -883.4

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	0.74	0.40	1.82	.067
Prime Condition PP-final	-0.93	0.30	-3.07	<.01
Prime Condition PP-medial	0.61	0.33	1.83	.067
Cumulative_PP-medial	0.01	0.02	0.41	.680
Prime Condition PP-final * Cumulative_PP-medial	0.03	0.04	0.83	.405
Prime Condition PP-medial * Cumulative_PP-medial	-0.02	0.04	-0.49	.624

Note. Final model = glmer(target response ~ Prime Condition * Cumulative_PP-medial + (1|Participant) + (1|Item), data = French, family = binomial)

Cumulative priming for PP-*final* passives

There was no significant PP-final cumulative priming effect (*b* = 0.00, 95% CI -0.06, 0.07], *p*=. 934) (see Table 5.S5). This entails that the learners did not produce more PP-medial passives in the baseline condition upon comprehending more PP-final passive primes in the previous trials.

Table 5.S5 Cumulative PP-final Passive Priming in the L2 Learners Data (*N* = 2130; log-likelihood = -883.4

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	0.79	0.41	1. 96	**.050**
Prime Condition PP-final	-0.98	0.31	-3.09	<.01
Prime Condition PP-medial	0.29	0.31	0.97	.330
Cumulative_PP-final	0.00	0.03	0.08	.934
Prime Condition PP-final * Cumulative_PP-final	0.03	0.04	0.84	.385
Prime Condition PP-medial * Cumulative_PP-final	0.02	0.04	0.64	.518

Note. Final model = glmer(target response ~ Prime Condition * Cumulative_PP-final + (1|Participant) + (1|Item), data = French, family = binomial)

Self-priming for PP-*medial* passives

There was significant self-priming of PP-medial passives (*b* = 0.07, 95% CI [0.03, 0.11], *p* =. 001) (see Table 6.S5): the odds for a PP-medial passive in the baseline condition increased together with the number of PP-medial passives produced on previous trials.

Table 6.S5 Self-priming of PP-medial Passives in the L2 Learners Data (*N* = 2130; log-likelihood = -883.4

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	0. 26	0.35	0.73	.463
Prime Condition PP-final	-0.53	0.24	-2.11	<.05
Prime Condition PP-medial	0.72	0.24	2.96	<.01
SelfP_PP-medial	0.06	0.02	3.47	<.001
Prime Condition PP-final * SelfP_medial	-0.02	0.02	-1.10	.271
Prime Condition PP-medial * SelfP_PP-medial	-0.03	0.02	-1.28	.200

Note. Final model = glmer(target response ~ Prime Condition * SelfP_PP-medial + (1|Participant) + (1|Item), data = French, family = binomial)

Self-priming for PP-*final* passives

There was significant self-priming of PP-final passives (*b* = -0.08, 95% CI [-0.13, -0.04], *p*=. 001) (see Table 7.S5): the odds for a PP-medial passive in the baseline condition increased together with the number of PP-final passives produced on previous trials. We also found a significant interaction between PP-medial priming and PP-final self-priming (*b* = 0.0, 95% CI [0.00, 0.11], *p*=. 027): PP-medial priming became stronger if participants produced more PP-final passives in previous trials (see Table 7.S5).

Table 7.S5 Self-priming of PP-final Passives in the L2 Learners Data (*N* = 2130; log-likelihood = -883.4

Fixed effects	***b*-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	1.29	0.35	3.63	<.001
Prime Condition PP-final	-1.05	0.23	-4.58	<.001
Prime Condition PP-medial	0.06	0.24	0.24	.806
SelfP_PP-final	-0.08	0.02	-3.49	<.001
Prime Condition PP-final * SelfP_final	0.05	0.03	1.90	.057
Prime Condition PP-medial * SelfP_PP-final	0.06	0.03	2.20	<.05

Note. Final model = glmer(target response ~ Prime Condition * SelfP_PP-final + (1|Participant) + (1|Item), data = French, family = binomial)

Appendix S6. An Excerpt from the Language Teaching Materials.

Though teachers do not penalize the production of PP-final passive structures by students, they teach students to use the PP-medial passive structure as they believe this will lead to less word order errors throughout other Dutch grammatical structures. The third row of the table below shows a rather explicit word order where the prepositional phrase (with *door – by*) precedes the past participle (the PP-medial passive structure, e.g., *De man wordt door de hond gebeten* - * *The man is by the dog being bitten).* In the PP-final passive structure, the past participle precedes the prepositional phrase. On the right is the English translation of the excerpt.

Het passief	*The passive*
Vorm Actief → De hond bijt de man. Passief → De man wordt door de hond gebeten.	*Form* *Active → The dog bites the man.* *Passive → *The man is by the dog being bitten.*
Hulpwerkwoord ("worden" of "zijn") + handelend voorwerp (**door**…) + participium Actieve zin: agens = subject Passieve zin: agens = handelend voorwerp (indien relevant)	*Auxiliary verb ("become" or "to be") + agent (**by**….) + past participle* *Active sentence: agent = subject* *Passive sentence: agent = object (if relevant).*

Appendix S7. Transitive Verbs and Nouns (below) Used in the Picture Set

Dutch Verb	**English Translation**	**Zipf-frequency (Keuleers et al., 2010)**	**AoA (Brysbaert et al., 2014)**
aanrijden	to hit	3.25	9.28
bedienen	to serve	3.85	8.89
bellen	to call	5.35	6.03
blokkeren	to block	3.67	8.72
dragen	to carry	4.91	5.78
groeten	to greet	4.48	6.71
helpen	to help	5.76	5.40
inhalen	to overtake	2.72	8.61
roepen	to shout	4.53	4.96
slepen	to drag	3.95	8.03
vervangen	to replace	4.41	9.06
volgen	to follow	4.99	5.84

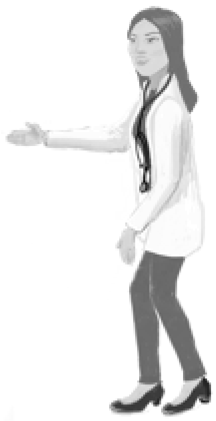
Aanrijden, *bellen*, *dragen* and *volgen* occurred 20 times in the picture set. The rest of the verbs occurred 16 times in the picture set.

List of Human Professions and Vehicles

The pictures are in black and white in this dissertation, but the original pictures are in colors (see https://tinyurl.com/DutchNormingStudy).

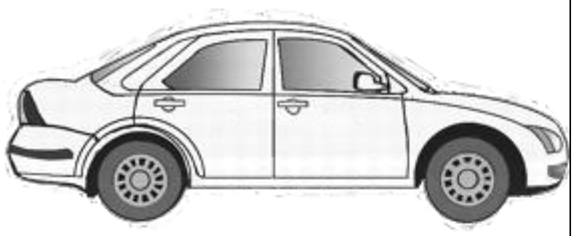
Human Professions	**English translation**	**Vehicles**	**English translation**
bakker	baker	ambulance	ambulance
bouwvakker	construction worker	auto	car
dokter	doctor	brandweer	fire truck
journalist	journalist	bus	bus
kok	cook	fiets	bike
leraar	teacher	motor	motor
slager	butcher	tram	tram
zangeres	singer	vrachtwagen	truck

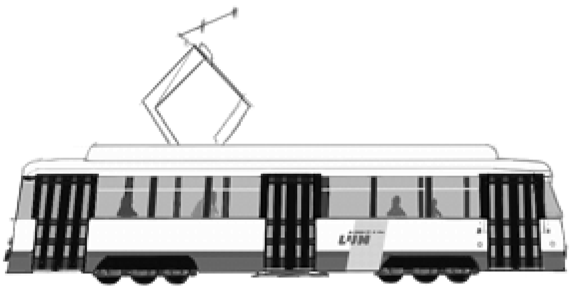
Human professions

bakker 	**bouwvakker** 
dokter 	**journalist** 

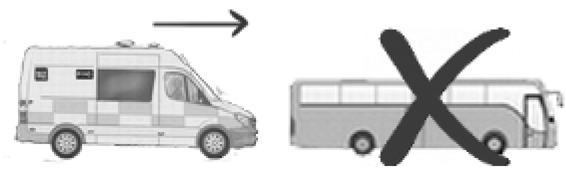
kok 	**leraar** 
slager 	**zangeres** 

Vehicles

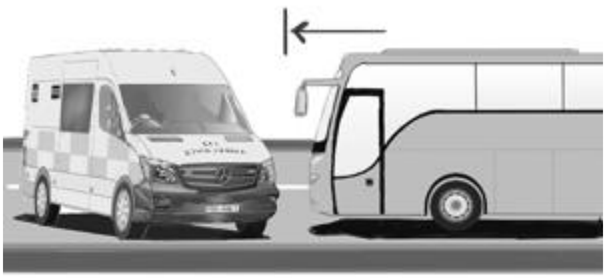
ambulance 	**auto** 
brandweer 	**bus** 

fiets 	**motor** 
tram 	**vrachtwagen** 

Appendix S8. Examples of pictures with the abstract verbs ‘vervangen’ [to replace]; ‘blokkeren’ [to block].



An example of a picture that depicts the sentence ‘De ambulance vervangt de bus’ – The ambulance replaces the bus



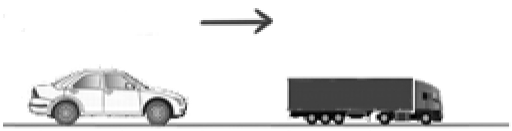
An example of a picture that depicts the sentence ‘De ambulance blokkeert de bus’ – The ambulance blocks the bus.

Appendix S9. Full output of final model with the predictors Condition (active condition as reference level), Verb (aanrijden as reference level) and Grade (high grade as reference level). (*N* =8278; log-likelihood = -1594.9)

Fixed effects	**β-coefficient**	**SE**	***Z*-value**	***p*-value**
(Intercept)	-5.58	0.51	-10.89	< .001***
Condition (passive)	1.55	0.40	3.86	<.001 ***
Verb (bedienen)	-0.67	0.90	-0.74	0.45
Verb (bellen)	-1.57	0.88	-1.78	0.07 .
Verb (blokkeren)	1.21	0.67	1.80	0.07 .
Verb (dragen)	-0.79	0.82	-0.96	0.33
Verb (groeten)	-0.31	0.80	-0.38	0.69
Verb (helpen)	0.16	0.74	0.22	0.82
Verb (inhalen)	2.37	0.58	4.06	<.001 ***
Verb (roepen)	-2.06	1.16	-1.77	0.07 .
Verb (slepen)	0.17	0.75	0.22	0.81
Verb (vervangen)	2.69	0.58	4.62	<.001 ***
Verb (volgen)	-1.58	0.91	-1.73	0.08 .
Grade (low)	1.80	0.41	4.37	<.001 ***
Condition (passive) * Verb (bedienen)	-0.88	0.57	-1.54	0.12
Condition (passive) * Verb (bellen)	1.26	0.72	1.74	0.08 .
Condition (passive) * Verb (blokkeren)	-1.89	0.56	-3.37	<.001 ***
Condition (passive) * Verb (dragen)	-0.08	0.64	-0.12	0.90

Condition (passive) * Verb (groeten)	-0.62	0.54	-1.15	0.24
Condition (passive) * Verb (helpen)	0.21	0.64	0.32	0.74
Condition (passive) * Verb (inhalen)	-1.12	0.46	-2.41	<.05 *
Condition (passive) * Verb (roepen)	2.11	1.06	1.98	<.05 *
Condition (passive) * Verb (slepen)	-1.09	0.56	-1.93	0.05 .
Condition (passive) * Verb (vervangen)	-0.82	0.47	-1.74	0.08 .
Condition (passive) * Verb (volgen)	2.30	0.81	2.82	<.01 **
Verb (bedienen) * Grade (low)	-1.47	0.80	1.84	0.06 .
Verb (bellen) * Grade (low)	0.63	0.62	1.02	0.30
Verb (blokkeren) * Grade (low)	-0.07	0.58	-0.13	0.89
Verb (dragen) * Grade (low)	0.37	0.65	0.57	0.56
Verb (groeten) * Grade (low)	1.52	0.70	2.18	<.05 *
Verb (helpen) * Grade (low)	-0.75	0.55	-1.36	0.17
Verb (inhalen) * Grade (low)	0.38	0.45	0.85	0.39
Verb (roepen) * Grade (low)	0.19	0.59	0.31	0.75
Verb (slepen) * Grade (low)	0.53	0.64	0.83	0.40
Verb (vervangen) * Grade (low)	-0.75	0.45	-1.66	0.09 .
Verb (volgen) * Grade (low)	0.07	0.50	0.15	0.88

Appendix S10. The Transitive Picture for “The car follows the truck”. Note the use of the Arrow.



The arrow indicates the direction of the transitive event. It is likely that people will first process “the car” as the agent, leading to an active interpretation, before processing “the truck”. Confusion may arise when people hear “the truck” first, since the direction of the arrow should then be disregarded.