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RESEARCH PAPER

The role of word order in bilingual speakers' representation of their two languages: the case of Spanish–Kaqchikel bilinguals

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Abstract When bilingual speakers plan to speak in one of their languages, the other language remains active and exerts an influence on the chosen language. However, the factors that modulate this influence, and particularly the extent to which syntactic structures and word order need to be the same in both languages for this influence to occur, are not yet fully understood. In this study, we explore the role of free word order in bilinguals' representation of their two languages by analyzing the connections of linguistic representations in Spanish–Kaqchikel early bilinguals, two languages that allow word order variation in transitive sentences. In Experiment 1, a structural priming experiment within Kaqchikel was conducted with voice and word order of prime as independent variables. Results showed priming of both structure and word order, independently from each other. In Experiment 2, cross-linguistic structural priming was used from Spanish to Kaqchikel. Results showed priming of voice, regardless of word order, but not priming of word order. Taken together, these results suggest that, in languages with greater flexibility in their basic word orders, structural selection and word order choice seem to be independent processes.

Keywords Kaqchikel · Bilingual sentence production · Cross-linguistic priming · Word order

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Introduction

Bilingualism and multilingualism constitute an everyday reality for a greater part of the population. In fact, a larger percentage of the population is regarded as bilingual compared to the population considered monolingual (Marian and Shook 2012). Yet, despite this reality, there is still little understanding of how bilinguals are able to produce sentences effectively in either of their languages: how bilingual speakers plan their speech, and how both languages are coactivated (and to what extent) in this process. Research on lexical production suggests both languages are always active, and both are connected (e.g. Kroll and Stewart 1994; Green 1998; Dijkstra et al. 1999; Kroll et al. 2006, 2012).

Less is known about the way in which sentence planning takes place in bilingual speakers. A common way in which researchers have tried to explore how,

and to what extent, languages are interconnected at the syntactic level is through structural priming. Structural priming has been extensively used to understand the way in which monolingual syntactic planning takes place. These studies show that speakers tend to repeat previous constructions they have been exposed to, suggesting that they engage in structural planning in parallel to the selection of the lexical items that will conform to their utterance. Compelling evidence for this was presented by Bock (1986). In this pioneering study, participants had to describe a picture using a ditransitive structure after reading either a ditransitive prepositional-object (PO) sentence (e.g. "A rock star sold some cocaine to an undercover agent") or a double-object (DO) sentence (e.g. "A rock start sold an undercover agent some cocaine"). Results showed that the likelihood of describing a picture using PO increased after repeating a PO sentence and the likelihood of describing a picture using DO increased after repeating a sentence using DO. The same priming effects were found with voice: after reading a passive sentence (e.g. "the referee was punched by one of the fans") participants were more likely to produce passive sentences than after reading a sentence in active voice. Later studies confirmed that these effects were not caused by repetition of function words (Bock 1989), and were independent of semantic repetition (Bock and Loebell 1990). This tendency to repeat recent structures was found also in other constructions, as the presence or absence of the complementizer "that" in relative clauses in English (Ferreira 2003) or RC attachment (Scheepers 2003) (see Mahowald et al. 2016 for a meta-analysis).

Not only can previous exposure to syntactic constructions shape the structure of the final utterance, but some evidence also suggests that word order within a language can be primed. Thus, if a certain word order was previously activated by the context, speakers will tend to produce the same word order in subsequent speech, which seems to show that speakers engage in the selection of word order somehow independently of the selection of the grammatical structure (whenever possible). That is, when there is more than one possible word order to fit the structure that the speaker wants to convey, previous exposure to a given word order will increase the likelihood of producing that word order. Hartsuiker and Westenberg (2000) presented evidence of this in Dutch, both in written and oral production. In Dutch clauses, the order of the auxiliary and the participle is free at the end of the clause, with no difference in constituent structure. In their experiment, they found that participants tended to produce auxiliary-final clauses after being exposed to auxiliary-final sentences and to produce participle-final clauses after being exposed to participle-final clauses. Similarly, Tanaka (2008) observed a priming of word order in Japanese, a language that allows scrambling. Thus, he found that sentences were misremembered as OSV sentences more often after reading OSV sentences than SOV sentences, and the opposite for SOV sentences. These results could point to a seemingly independence of structural and linear information, allowing for priming of either one or the other. However, Pickering et al. (2002) found that when word order differed, structural priming of ditransitive DO/PO constructions was blocked within languages, thus suggesting a complex interconnection between syntactic structures and the linear word order in which they are presented. These authors presented participants with DO, PO and shifted PO constructions, as in (1):

(1)

(a) The racing driver showed the extremely dirty and badly torn overall to the mechanic. (PO)

(b) The racing driver showed the mechanic the extremely dirty and badly torn overall. (DO)

(c) The racing driver showed to the mechanic the extremely dirty and badly torn overall. (shifted PO)

Their results showed that upon the presentation of a shifted PO structure prime, participants did not produce more PO sentences than upon the presentation of a control intransitive prime. Non-shifted PO primes resulted in an increased number of PO sentences, suggesting it was the shift that made this connection disappear.

This apparent controversy about the role of word order and its independent selection from structural choice can also be found in studies of language production that address online sentence planning by means of the eye-tracking methodology (see Griffin 2004 for a review of the use of this methodology in language production). These studies show that, in general, speakers tend to plan the elements of the

sentence in the same order as they are going to utter it (Griffin and Bock 2000). Based on this observation, some studies (e.g. Gleitman et al. 2007; Brown-Schmidt and Konopka 2008; Myachykov and Tomlin 2008) suggest that planning of the linear order starts right from the beginning, accessing the lexical items in the same order as sentences are going to be produced, such that lexical access seems to go along with structural planning. Thus, according to this view, known as *Linear Incrementality Hypothesis*, linear information and structural information are planned together in a closely related fashion, as a way to ensure incremental planning and, therefore fluency. However, several studies, either with within-language manipulations (van de Velde et al. 2014; Konopka and Kuchinsky 2015; Konopka 2012) or with cross-linguistic comparisons (Ganushchak et al. 2014; Norcliffe et al. 2015; Kubo 2016; Rodrigo et al. 2018), seem to show that this relation is not as straightforward. Thus, in contrast with linear incrementality, the *Structural Incrementality Hypothesis* proposes that, in order to be able to plan the linear order, and, therefore access the corresponding lexical items, a structural scaffold (that is, a tentative frame that contains the relations between elements and between a message's conceptual representation and the syntactic frame—Bock and Ferreira 2014) has to be created. Otherwise, speakers might start a sentence they do not know how (or are unable) to finish (Bock et al. 2004). This is especially visible in languages where the head of the sentence (e.g. the head noun in relative clauses) or the subject are placed later in the utterance. For example, in Japanese relative clauses the head is not uttered until the end of the clause, after all its subordinate elements. However, speakers showed extensive focus on the head noun before turning to plan the lexical elements in order (Rodrigo et al. 2018). Importantly, this is also the case for VOS languages, like Tagalog[1] (Sauppe et al. 2013), Tzeltal (Norcliffe et al. 2015) or Kaqchikel (Kubo 2016). In these languages, the agent is focused on the first place, before gazes are distributed evenly between agent and patient, a pattern that has been suggested to represent planning of the event. These results suggest that, in languages or structures where hierarchical and linear representation do not match, a structural scaffold has to be created in order for the speakers to start retrieving the lexical elements in order.

In sum, the evidence supporting both hypotheses, as well as evidence showing the flexibility of planning scope (e.g. Wagner et al. 2010; Ferreira and Swets 2002) suggests that sentence planning seems to move more in a continuum (Norcliffe and Konopka 2015). Languages like English, where structural and linear mapping frequently converge, rely more heavily on linear incrementality (i.e. on planning structural and linear information together). This is also the case for easier or highly automated structures, like Noun Phrases, where there is little need for advance planning (e.g. Griffin 2001; Brown-Schmidt and Konopka 2008). On the contrary, structures that are more difficult to plan, or in languages where linear and structural planning do not match as frequently (like VOS languages), the trend leans more toward structural incrementality (i.e. planning structure before linear order). These results, then, seem to suggest that the role of word order in monolingual sentence planning varies between languages and even between structures in the same language.

Much less is known about how sentence planning unfolds in bilingual speakers in both their L1 and their L2. Konopka et al. (2018) showed that bilingual speakers engage in a more extensive event planning in their L2 than in their L1, suggesting that they rely on hierarchical planning to a greater extent. In other words, bilingual speakers prefer to plan a greater chunk of the utterance in their L2 prior to lexical access in order takes place. Importantly, however, speakers were able to shift their strategies with time: from hierarchical planning to linear planning, showing flexibility due to habituation to the task.

Similarly to the case of monolinguals, structural priming in bilingual speakers has been extensively used to understand how sentence planning takes place in either of the languages of the bilingual speaker and how both languages are related to each other. Specifically, cross-linguistic structural priming provides a measure of the extent to which the activation of one structure in one language can result in the activation of the same syntactic structure in the other, as well as of the factors that modulate this cross-linguistic influence. Making use of this technique, previous research has shown that a bilingual's two languages are connected at the structural level, with shared representations of similar syntactic structures. Hartsuiker

[1] Tagalog allows for both VSO and VOS word orders (see Sauppe et al. (2013) for more details).

et al. (2004) showed evidence of this interconnection for Spanish–English bilinguals. In their study, participants were paired with a confederate in a dialogue game. In this game, both confederate and participant were told they had to describe cards to each other; however, the confederate was reading sentences printed in her own cards. The confederate was reading cards in Spanish (L1) while the participant had to describe her pictures in English (L2), with primes (i.e. the sentences read in Spanish) being presented in active and passive voice. Results showed an increased likelihood of producing passive sentences in English after hearing a description in a passive form in Spanish. Similarly, other studies have found similar cross-linguistic priming of structures with DO/PO structures (Loebell and Bock 2003), RC attachment (Desmet and Declercq 2006; Hartsuiker et al. 2016) or genitive type (Bernolet et al. 2013), but with varying strengths in the connections depending on L2 proficiency (Bernolet et al. 2013). However, when word order differs between languages the results are not so clear. Bernolet et al. (2007) explored whether cross-linguistic priming actually occurs even when word order differs. They explored priming in adjective-noun constructions (e.g. "The red shark") and relative clause constructions (e.g. "The shark that is red"). In this study they compared cross-linguistic priming between English and Dutch, languages that differ in the verb position in the relative clause construction, with cross-linguistic priming between Dutch and German, where the order is exactly the same. Results showed priming between Dutch and German (the pair with the same word order) but not between Dutch and English; the authors concluded that structure and word order are represented in the same node, and that both must be shared between languages for the structure to be shared. Similarly, Loebell and Bock (2003) failed to find priming effects between English and German active/passive structures, since the word order differs in both languages. However, not all studies have found the same pattern when word order differs. For example, contrary to Bernolet et al.'s results (2007), Desmet and Declercq (2006) found cross-linguistic priming between Dutch and English for relative clauses, The authors found priming on the preference for high or low attachment in relative clauses between these two languages, despite the difference in word order. Similarly, Shin and Christianson (2009) found evidence of priming between Korean and English in PO/DO structures. Chen et al. (2013) also found that, despite differences in word order (in this case between Chinese and English passive structures), cross-linguistic priming occurs both in comprehension to production priming and in production to production priming.[2]

This conflicting evidence suggests that this issue is far more complex than previously thought, making it difficult to understand the role of word order in the way the bilingual's two languages are represented. However, it seems to suggest that factors like word order flexibility in the target language, frequency of the targeted structure or speakers' proficiency might modulate the effect of word order on sentence planning by bilingual speakers. In our current study we explore the first of these factors by analyzing cross-linguistic priming in balanced Kaqchikel–Spanish bilinguals. As it will be explained with more detail in the next section, Kaqchikel is a Mayan language spoken in Guatemala, whose canonical word order is VOS but that allows SVO (a preferred word order in picture description tasks—Kubo 2016) or VSO orders as well. Spanish, on the other hand, is a SVO language with a much more fixed word order than Kaqchikel, but that still allows considerable flexibility in transitive sentences by means of topicalization. This will be also discussed in more detail in the next section. Thus, the main aim of this study is to examine how languages are represented in a bilingual's mind when both allow flexibility in word order, by exploring word order (SVO and VOS orders) and structural (active and passive voice) priming in simple transitive clauses. This 2 × 2 comparison will allow us to tell apart and thus understand the role of word order and structural selection as independent factors, as well as to explore the interaction between both processes.

Kaqchikel

Kaqchikel is a Mayan language from the Kichean branch spoken in the highlands of central Guatemala. As other languages of the Kichean branch,

[2] Hatzidaki et al. (2018) also showed that differences in word order between L1 and L2 give rise to errors in a sentence completion task, thus suggesting that the L1 word order is active and competing when only the L2 has to be produced. Interestingly, the effects were not modulated by the relative distance in word order between the L1 (either Spanish or Dutch) and the L2 (English).

Kaqchikel's basic word order is VOS, allowing for SVO and VSO as well. However, in comparison with other Kichean languages, Kaqchikel use of SVO order is more widespread and easily interpretable, with most utterances being produced as either VOS or, when the interpretation can be ambiguous, as SVO (England 1991). Interestingly, despite VOS being considered the canonical word order, SVO is produced much more often than VOS, at least in controlled picture naming studies (Kubo et al. 2015; Kubo 2016). Specifically, along a series of different experiments, these authors found that SVO word order is used in over 80% of the utterances.

England (1991) explains this discrepancy between the supposed canonical word order and preferred word order as part of the defining characteristics of word order in Mayan languages: canonical word order in Mayan languages is present with definitive subject, a type of subject found only in utterances that introduce old information. Therefore, utterances introducing new information (as it is the case of sentences describing isolated pictures in experimental settings) result in topicalized SVO sentences. Nevertheless, the case in Kaqchikel Mayan is more complex than in other Mayan languages, with speakers of some variants of Kaqchikel having problems understanding VOS sentences. For example, speakers of Patzun Kaqchikel only understand sentences with VOS word order as questions (when both agent and patient are animate) (Kim 2011). Thus, some authors argue that Kaqchikel basic word order is shifting or has already shifted to SVO as canonical word order (Brown et al. 2006; Kim 2011). Interestingly, however, even in modern Kaqchikel, VOS word orders result in less processing costs than SVO in fMRI and ERP studies (Koizumi et al. 2014; Yasunaga et al. 2015; Koizumi and Kim 2016; Yano et al. 2017).

Kaqchikel is an ergative and head-marking language: nouns do not contain any case marking, which relies exclusively on the verb. The verb is marked with number and person for both the object (absolutive) and subject (ergative). The information is represented in the verb in the following fashion [aspect—Absolutive case (O)—Ergative case (S)—Verb stem]. For example (from Broadwell and Duncan 2002):[3]

(2) X-in-ki-k'utuj.
COM-1SA-3PE-ask[3]
"They asked me."

Kaqchikel also allows for variation of voice, distinguishing between active and passive. More specifically, there are three types of passive sentences in Kaqchikel: standard passives, perfective passives and Ki-passives.

The standard passive in Kaqchikel is marked by a change in vowel in the root of the verb (a change that differs between root verbs and derived verbs). Additionally, while in the active form, the agent triggers an ergative marking in the verb (3a), in the passive, the agent takes the position of the possessor of the relational noun and is preceded by the word *r-oma'* ("by") which contains the ergative marking of the agent (3b). Verb marking takes marking of an intransitive sentence: the subject (the patient) receives the absolutive case, and the ergative case is missing from the verb, which is shifted to the position of the word *r-oma'* (Kubo 2016; see also Broadwell and Duncan 2002 for more details and examples):

(3)

(a) Ri achin	x-u-ch'äy	ri tz'i'	
the man	COM-3SA-3SE-hit	the dog	
"The man hit the dog."			
(b) Ri tz'i'	x-ch'ay	r-oma'	ri achin
the dog	COM-3SA-hit:PASS	3SE-by	the man
"The dog was hit by the man."			

Word order can also be verb initial in passive sentences, but, in this case, the word order will obligatorily change to VSO, that is, the argument with *r-oma'* takes the final position of the sentence as can be seen in (4) (example from Broadwell 2000):

(4) X-oqotäx	ri achin	r-oma'	jun tz'i'.
COM-chase:PASS	the man	3sErg-by	a dog
"The man was chased by a dog."			

The perfective passive differs from the standard passive exclusively in aspect. This type of passive

[3] Glosses in Kaqchikel examples will be the following: COM = Completive aspect; PASS = Passive voice; E = Ergative; A = Absolutive; S = Singular; P = Plural.

emphasizes the completion of an activity (Broadwell and Duncan 2002):

(5) Ri tz'i' x-chap-atäj r-oma' ri achin
the dog COM-grab-PASS 3sE-by the man
'The dog has been grabbed by the man.'

According to Kubo (2016) both types of passives can be united as a single, standard passive, as opposed to the ki-passives.[4] Only standard and perfective passives will be used in this study.

Spanish

In contrast with Kaqchikel, Spanish is a nominative language whose canonical word order in transitive sentences is SVO. In this brief summary we will focus on transitive sentences, since they are the target of our study.

In Spanish, the order of the components in transitive sentences can vary. Thus, as shown by Fernández Soriano (1993), in Spanish all of the following word orders are possible (examples from Fernández Soriano 1993; annotation and translation added), even if they entail different emphases:

(6)
(a) SVO: Juan ha comprado el periódico.
Juan buy-3PS-presPerf the newspaper.
(b) VSO: Ha comprado Juan el periódico.
buy-3PS-presPerf Juan the newspaper.
(c) VOS: Ha comprado el periódico Juan.
buy-3PS-presPerf the newspaper Juan.
"Juan has bought the newspaper"

This variation is possible thanks to a rich morphological system. In Spanish, the verb is marked with the number and person of the subject. Objects do not cause any marking in the verb, and no overt marking is encountered when inanimate objects are found. Human objects are, nonetheless, marked with the preposition "a" before them, avoiding ambiguity.[5] For example, contrast (6a) above with (7):

(7) Juan ha despertado **a** Alicia
Juan wake up-3PS-presPerf to-OBJ Alicia.
"Juan has woken up Alicia"

However, despite this possibility, verb initial utterances, especially when both subject and object are animate, are much more limited than in the case of Kaqchikel. They are only possible when topicalization of the event occurs. Note that, in contrast with Kaqchikel, topicalization in Spanish is found in the VOS order, while in Kaqchikel SVO sentences are the ones that are topicalized.

Limitation on the position of the subject is also found in passive sentences, where the subject (the patient of the action) is never postponed to the final position of the sentence. That is, it never appears after the complement. Consider the following examples:

(8)
(a) El periódico fue comprado por Juan
The newspaper buy-PASS-Past by Juan
(b) Fue comprado el periódico por Juan
Buy-PASS-Past the newspaper by Juan
(c) ?? Fue comprado por Juan el periódico
Buy-PASS-Past by Juan the newspaper
"The newspaper was bought by Juan"

As mentioned above, the same constraint was found in Kaqchikel. In this experiment, we will focus on active and passive sentences with word orders that matched the most common (or less marked) word orders in Kaqchikel: Active SVO (6a) and VOS (6c) and Passive SVO (8a) and VSO (8b).

[4] Ki-passives are similar to standard passives in the sense that the patient will take the subject role, while the agent will be placed as a complement. However, in contrast to standard or perfective passives, the ki-passives retain the marking of ergative and absolutive elements. However, the ergative marking does not show agreement with the subject (the patient) but shows a third person plural marking (ki) (Kubo 2016; for a detailed explanation of Ki passives, see Broadwell and Duncan 2002)

(1) Ri ala' x-ki-ch'äy r-oma' ri xtän.
DET boy COM-A3S-E3P-slap E3S-by DET girl
"The boy was slapped by the girl"

Par21 :

[5] An ambiguity that is present in many of the VSO/VOS sentences in Kaqchikel (England 1991).

The current study

As we introduced in the previous section, the role of word order in cross-linguistic structural priming and the variables that might influence it are still not fully understood. With this question in mind, we decided to explore the interconnection between languages in bilinguals of languages whose word order varies freely (in the case of Kaqchikel) or, at least, shows greater flexibility than English (such as Spanish) in their basic constructions. In order to explore this, we conducted two structural priming experiments: the first one, within Kaqchikel and the second, from Spanish (L2) to Kaqchikel (L1). Our main aim was to test whether cross-linguistic structural priming is present in simple transitive clauses in languages with extensive word order variation. Is shared word order a necessary requisite for structures to be shared?

Experiment 1: Kaqchikel to Kaqchikel priming

As a language that has been understudied so far, whether or not structural priming or word order priming are present within a language with as much variability and freedom as Kaqchikel remains an open question. For that reason, we decided to conduct first a structural priming experiment within Kaqchikel to explore how structures are represented and connected within this language.

Method

In order to address this open question, we conducted an experiment in which we controlled for the voice and the word order of the primes, in a 2 (voice: active vs. passive) × 2 (word order: SVO vs. verb initial) design.

Participants

19 Kaqchikel–Spanish early bilinguals (13 female) participated in this study. The mean age was 31.11 (range 20–47). All participants rated Kaqchikel as their native language and Spanish as their second language. However, the language used in instruction (from kindergarten onwards) was Spanish for all participants, resulting in a flip on dominance (see self-rated proficiency in Table 1, below). Despite all participants reporting Kaqchikel as the language spoken at home, 4 participants reported that they started speaking this language later than Spanish by a year or more.

In order to participate in this study, participants had to be able to read in Kaqchikel, however the age of acquisition of Kaqchikel reading (mean 15.65) is later than Spanish reading (mean 7.44) ($t(15) = 3.85$, $p = 0.0016$) and Kaqchikel oral expression (mean 4.41) ($t(16) = 4.96$, $p < 0.001$). Participants self-rated proficiency mean scores as well as reported age of acquisition (AoA)[6] can be found in Table 1.

Materials

There were a total of 48 experimental pictures (24 of them acting as primes and 24 as targets). Experimental items represented a transitive action, involving two animate arguments. Each picture was presented along with a verb in the infinitive form that denoted the action and that participants had to use in order to describe the scene. Verbs for prime and target were repeated, but each pair was repeated only once (with a total of 12 different verbs for each experimental condition). These items were presented along with 96 filler items (48 primes/48 targets), depicting intransitive events. In the case of fillers, half had the verb repeated between prime and target and half did not. This was done to ensure variety but also was due to difficulties in preparing matches for all actions. For each prime, four versions were constructed with the two different voices and the two different word orders. As it was explained above, in Kaqchikel it is not possible to produce VOS in passive sentences, but only VSO sentences. Thus, the sentences types used in this experiment were active SVO/passive SVO; active VOS/passive VSO; these last two will be referred to as verb initial (henceforth, V-initial) primes. An example of four possible prime combinations can be found in

[6] The exact question was "age in which you started learning each language with respect to… oral expression". As it can be seen in Table 1, self-assessed AoA is quite high. This is also true for Experiment 2. In Experiment 1, it could be due to a wide range of ages, but it is also true in both experiments that the earliest age that participants report in either of their languages is elevated (3 or 4 years old), showing a problem with the self assessed nature of this report. Therefore, we consider that the important factor we might need to take into consideration is whether or not there are differences between Kaqchikel and Spanish, rather than the exact reported AoA.

Table 1 Reported age of acquisition and self-rated proficiency (mean and standard deviation) in Spanish and Kaqchikel in a 1 (no capacity) to 7 (excellent) Likert scale

	Age of acquisition	Speaking	Listening	Reading	Writing
Spanish	4.39	5.44	5.81	5.35	5.56
	(range 0–9)	(SD 1.31)	(SD 0.98)	(SD 1.27)	(SD 0.81)
Kaqchikel	4.86	5.22	4.94	4.5	3.89
	(range 0–20)	(SD 1.7)	(SD 2.01)	(SD 1.76)	(SD 1.74)

Table 2 Example of the four possible combinations of items used in Experiment 1 and Experiment 2

	Active	Passive
SVO	**Spanish:**	**Spanish:**
	Aquí el policía atrapa a la anciana	Aquí la anciana es atrapada por el policía
	Kaqchikel:	**Kaqchikel:**
	Wawe la ajpotz' nuchäp la ti ixöq	Wawe la ti ixöq nichap ruma la ajpotz'
	(Here the policeman caught the old lady)	*(Here the old lady was caught by the policeman)*
V-initial	**Spanish:**	**Spanish:**
	Aquí atrapa a la anciana el policía	Aquí es atrapada la anciana por el policía
	Kaqchikel:	**Kaqchikel:**
	Wawe nuchäp la ti ixöq la ajpotz'	Wawe nichap la ti ixöq ruma la jun ajpotz'
	(Here caught the old lady the policeman)	*(Here was caught the old lady by the policeman)*

Table 2.[7] This rendered a 2×2 within-subject design, with voice (active vs. passive) and word order (SVO vs. V-initial) as independent variables. Amount of passive responses and amount of V-initial responses was used as dependent variables.

Procedure

The main task was conducted with a confederate-scripting task. Instructions were given in Kaqchikel throughout the whole procedure. After filling a Language Background Questionnaire, participants were introduced to another Kaqchikel speaker who, supposedly was going to participate with them in the task: this was the confederate. Both participant and confederate were seated before laptops and facing each other, so the screen of each one was not visible to the other party. Before starting the main task, both participant and confederate examined the verbs that were going to be used throughout the whole task to make sure that they understood them and were able to use them.

After the study phase, the main experiment began. Participant and confederate were given instructions that they were going to see a picture and that they had to describe what they saw to each other by using the provided verb. They were told that sometimes the picture that was displayed was the same and sometimes it was different, so their task consisted of deciding whether the picture they had before them was the same that the other participant had just described. However, the confederate was actually seeing the picture with a sentence printed at the bottom and reading the sentences, which acted as primes. Half of the sentences matched the picture that the participant saw while the remaining half differed in the characters shown but not in the action. Pictures were presented using E-prime 2.0.

[7] As mentioned previously, VOS is a topicalized word order in Spanish, with event acting as the topic. Therefore, in order to make it more appropriate to the context of describing pictures we added the adverb "Here" at the beginning of all sentences, both in Kaqchikel (in Experiments 1 and 2) and in Spanish (in Experiment 2).

Table 3 Proportion and count (in parenthesis) of each type of responses by order for the different types of primes and in total

Response		Prime				Total
		SVO active	VOS active	SVO passive	VSO passive	
Active	SV(O)	0.806 (87)	0.578 (63)	0.721 (75)	0.59 (59)	0.675 (284)
	VOS	0.157 (17)	0.275 (30)	0.106 (11)	0.18 (18)	0.18 (76)
	VSO	0.018 (2)	0.064 (7)	0.01 (1)	0.05 (5)	0.036 (15)
	VS	0.009 (1)	0.018 (2)	0.019 (2)	0.03 (3)	0.019 (8)
	OVS	0	0	0.019 (2)	0	0.005 (2)
Passive	SVO	0	0	0.038 (4)	0.01 (1)	0.012 (5)
	VSO	0.009 (1)	0.046 (5)	0.086 (9)	0.12 (12)	0.064 (27)
	VS	0	0.018 (2)	0	0.02 (2)	0.009 (4)
Total count		108	109	104	100	421

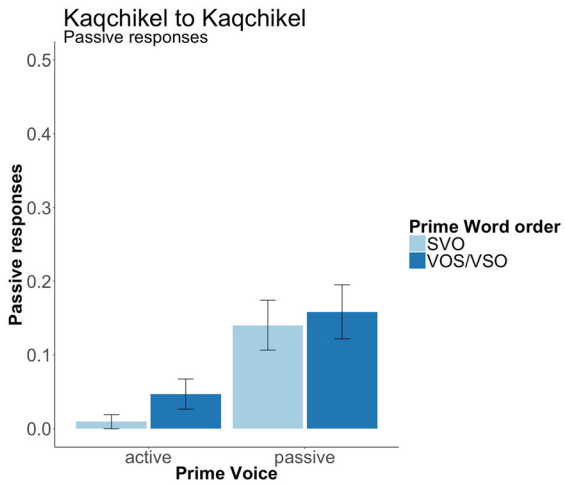

Fig. 1 Proportion of passive responses for the different type of primes in Experiment 1 (Kaqchikel to Kaqchikel)

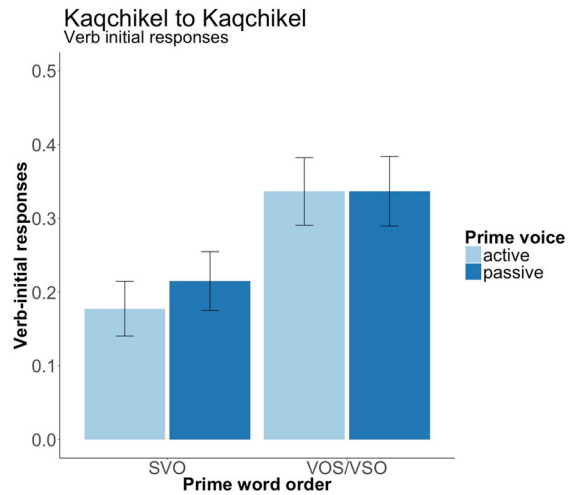

Fig. 2 Proportion of verb initial responses for the different type of primes in Experiment 1 (Kaqchikel to Kaqchikel)

Results

Analysis

Responses were transcribed, translated to Spanish, and coded for word order and voice by two Kaqchikel native speakers with a formal knowledge of Kaqchikel linguistics. Excluded responses included (1) responses that failed to use transitive verbs; (2) responses that used a verb with a meaning far from the one provided;[8] (3) responses where the voice was not clear. Twenty-two responses were excluded due to these reasons (4.82% of the total responses). Count and proportions of the different type of responses can be found in Table 3.

VSO, VOS and VS. responses were coded as V-initial responses, while SV and SVO responses were coded as Subject (S)-initial responses. OVS. responses, due to its low proportion, were coded as "others" and not included in the model.

Two Generalized Linear Mixed Models with binomial distribution were built. The first had presence or absence of passive responses as dependent variable (henceforth, DV) while the second had presence or absence of V-initial responses as the DV. Both models had voice and word order of prime sentence (and their interaction) as fixed effects. Voice and word order priming effects were transformed into z-scores prior to fitting the model. A step-wise comparison of models

[8] Responses with different verbs that entailed the same meaning as the one provided were kept as correct.

was conducted for random and fixed effects; based on this: (1) the model with amount of passive responses as the DV included the random slope of word order of prime for subjects; (2) the model with amount of V-initial responses as the DV included prime word order as random slope for both subjects and items.

Results

For the first model, with the amount of passive responses as the DV, the inclusion of prime voice as a fixed effect significantly improved the model ($\beta = 2.4728$; z = 3.812, $p < 0.001$). However, there was no significant improvement due to the inclusion of prime order or the interaction ($ps > 0.1$). Results show an increase of responses that use passive voice upon listening to passive primes, regardless of the word order of the prime (Fig. 1).

For the second model, with the amount of V-initial responses as the DV, the inclusion of prime word order as a fixed effect contributed to significantly improve the model ($\beta = 1.44$; z = 2.209, $p = 0.027$). There was no significant improvement due to the inclusion of prime voice or the interaction ($ps > 0.1$). Similarly to the case of passive responses, in this case, the results show an increase of V-initial responses upon listening to V-initial primes, either VSO passives or VOS actives (Fig. 2).

Discussion

Results in Experiment 1 show that within Kaqchikel, previous exposure to a certain structure (i.e. passive sentences) increases the likelihood of producing that structure again. This result is in line with previous literature (e.g. Bock 1986; Ferreira et al. 2008; Myachykov et al. 2012). The results also showed that exposure to V-initial structures increased the likelihood of producing V-initial structures, replicating Tanaka (2008) and Hartsuiker and Westenberg (2000) results. Interestingly, these priming effects were independent of each other. There was an increase of passive utterances upon listening to passive primes, regardless of the word order in which the prime was presented; that is, both SVO passives and VSO passives increased passive sentences, regardless of the chosen word order. The same happened with word order priming: the amount of V-initial responses increased upon listening to V-initial sentences, regardless of the voice of the prime sentence. This is especially remarkable, since active and passive sentences differed in the position of the S: active sentences presented the subject at the end of the sentence (VOS—action patient agent) while passive sentences presented the subject right after the verb (VSO—action patient agent). Thus, the position of the verb seems to play an important role in deciding final word order in this language. Further studies are needed in order to fully understand the role of the verb position in priming with respect to other constituents on the sentence.

Experiment 2: Spanish to Kaqchikel priming

The previous experiment confirmed previous findings of within language structural priming in other languages with the case of Kaqchikel. However, these speakers are also fluent in Spanish, which is in many cases their dominant language. Therefore, the necessary next step was to explore the connections between Spanish and Kaqchikel at the structural and word order level.

Despite the otherwise wide differences between Kaqchikel and Spanish, the different canonical word order (VOS vs. SVO) and hence the differences in topicalization, both languages share word orders amidst their variations. As was discussed in the introduction, both languages share grammatical properties as well in terms of variation between active and passive voice. The question that arises now is how basic transitive sentences are represented in the minds of these bilinguals. Is there a representation of VSO passive and another of SVO passive in Kaqchikel, only the latter being shared with Spanish? Note that Spanish also allows for V-initial constructions under highly marked situations: will these structures be the ones that are shared with V-initial structures in Kaqchikel?

Alternatively, these extensive differences between languages, both in word order and in grammar (ergative language vs. nominative language, differences in head marking, etc.), could make bilinguals create separate stores for their structural information. Finally, it is also possible that, in the case of languages with free word order variation, structural and linear information are accessed and planned at different stages during the planning process. In this experiment, we will explore these possibilities.

Method

We conducted a cross-linguistic structural priming experiment from Spanish (their dominant language) to Kaqchikel. Same as in Experiment 1, the voice and word order of the primes was controlled in a 2 (voice: active vs. passive) × 2 (word order: SVO vs. V-initial) design.

Participants

Twenty-seven Kaqchikel–Spanish early bilinguals, who did not participate in Experiment 1, took part in this study. One of them was excluded due to low proficiency in Kaqchikel. A total of 26 participants were included in the analysis (14 females). Mean age was 33.23 (range 21–59). All participants reported having Kaqchikel as their native language, being spoken at home since birth. Fourteen participants reported that both Kaqchikel and Spanish were spoken at home. However, reported age of acquisition show that six participants consider they started speaking Kaqchikel later than Spanish by 1 year or more. Self-rated proficiency measures, as well as reported age of acquisition, can be found in Table 4.[9]

Materials

Experimental items consisted of 96 pictures depicting transitive actions involving two animate arguments[10]: 48 of them acted as primes and the remaining 48 as targets.[11] These items were presented along with 144 pictures depicting intransitive actions (72 primes and 72 targets), which acted as fillers. Same as in Experiment 1, each picture had a verb in the infinitive form printed at the bottom of the picture. The verbs for the primes and targets were repeated and each verb was used in two different pairs in the task, with a total of 12 different verbs in each experimental condition. Similarly, 48 filler items (24 pairs) shared the same verb between prime and target. The remaining 96 items had different verbs.

An example of four possible prime combinations can be found in Table 1 above.

Procedure

The main task was conducted with a confederate-scripting task following the same procedure described in Experiment 1. In this experiment instructions were given in Kaqchikel throughout the whole procedure as well. Same as in Experiment 1, after filling a Language History Questionnaire, and before starting the main task, both participant and confederate examined the verbs that were going to be used throughout the whole task, in this case they examined them in Spanish and in Kaqchikel. In this case, the participant was told their partner (i.e. our confederate) would describe the pictures in Spanish and they would have to judge whether what the partner said corresponded to the picture they had before them. Subsequently, they had to describe their own picture in Kaqchikel. Instructions were presented so the participant thought they were randomly assigned to Kaqchikel.

Results

Analysis

Similarly to Experiment 1, participants' responses were transcribed, translated to Spanish and coded for word order and voice by the same two Kaqchikel native speakers. Likewise, excluded responses included (1) responses that failed to use transitive verbs; (2) responses that used a verb with a meaning far from the one provided; and (3) responses where the voice was not clear. 76 responses were excluded due to these reasons (6.21% of the total responses). The count and proportions of the different type of responses can be found in Table 5.

VSO, VOS and VS. responses were coded as V-initial responses, while SV and SVO responses were coded as S-initial responses. OVS. and OSV responses

[9] The question this time was simply "At what age did you start talking Spanish/Kaqchikel?". Note that, similarly to Experiment 1, reported AoA is high in general, due to individual differences in the way in which they considered they started speaking that language with some speakers reporting an AoA o 6 or 7 years old for both of their languages. The difference in reported AoA between Kaqchikel and Spanish was taken to determine their L1, rather than the specific age they reported.

[10] All of the agents were human arguments while 7 pictures depicted an animal patient (4 primes and 3 target sentences).

[11] The number of items is twice as many as in Experiment 1 because Experiment 1 was part of a larger set of experiments and we could only allocate half of the items. The set of items in this experiment consists of the same 48 pictures (consisting of 12 depictable actions) from Experiment 1 plus another 48 pictures (another 12 depictable actions).

Table 4 Reported age of acquisition and self-rated proficiency (mean and standard deviation) in Spanish and Kaqchikel in a 1 (no capacity) to 7 (excellent) Likert scale

	Age of acquisition	Speaking	Listening	Writing	Reading
Spanish	4.6	5.88	6.23	6.08	6.15
	(range 0.5–17)	(SD 0.78)	(SD 0.76)	(SD 0.74)	(SD 0.67)
Kaqchikel	4.21	6.04	6.35	5.08	5.61
	(range 0.5–15)	(SD 0.84)	(SD 0.69)	(SD 1.72)	(SD 1.27)

(one of each) were coded as "others" and not included in the model.

Same as in Experiment 1, two Generalized Linear Mixed Models with binomial distribution were built. The first had presence or absence of passive responses in Kaqchikel as the DV and the second had presence or absence of V-initial responses in Kaqchikel as the DV. Voice and word order of primes were z-centered and included as fixed effects. A step-wise reduction and comparison of models was conducted for random effects. Based on this, word order of prime was included as a random slope for subjects only in both models.

Results

In the first model, with amount of responses in the passive voice as the DV, the inclusion of voice of prime as fixed effect significantly improved the model ($\beta = 0.84$; $z = 2.83$, $p = 0.0046$). However, neither the inclusion of word order as a fixed effect, nor the interaction between voice and word order improved the model ($ps > 0.1$). Upon listening to a prime in Spanish with passive voice, participants produced more passive utterances in Kaqchikel than after listening to primes produced in the active voice. This effect was independent of word order variation (Fig. 3).

In general, SVO active responses were overwhelmingly preferred (see Table 5). Likewise, the increase in passive responses after passive primes is focused on SVO responses. SVO passive responses increase after passive primes, regardless of the word order of the Spanish prime (SVO or VSO).

On the other hand, in the second model, with number of V-initial responses as the DV, there was no significant improvement of including prime word order as fixed effect nor when including prime voice or the interaction between both fixed effects ($ps > 0.1$) (Fig. 4).

Discussion

In Experiment 2, we analyzed how Spanish and Kaqchikel are related in these bilingual speakers, at the structural and word order level. The results showed that exposure to sentences in the passive voice in Spanish increased the likelihood of producing passive sentences in Kaqchikel. Interestingly, however, passive voice priming took place regardless of the word order of the prime, suggesting both structural information and linear information are accessed separately by these speakers to a certain extent.

In this study, we found no evidence of word order priming between languages. This is an intriguing result that could be attributed to several factors, all of which would require further research for clarification.

It could be that there are actually no connections between languages when planning the linear order of the utterance. However, it is also possible that this lack of effect is due to other reasons related to the pair of languages chosen: in Spanish VOS/VSO word orders are highly marked, while the SVO is the supposed marked word order in Kaqchikel. This marked to unmarked priming could block any connections between languages when selecting word order.

It is also possible that the difference between VOS and VSO for active and passive, respectively, blocked priming. In Experiment 1 we found priming of word order despite the difference in the relative position of subject and object for active and passive. However, the Kaqchikel verb marking system differs from Spanish, which could result in a different outcome. In Kaqchikel, as was previously introduced, verbs are marked with the number and person of both object and subject, and this is true for both VOS and VSO sentences. However, this is not the case for Spanish.

Table 5 Proportion and count (in parenthesis) of each type of responses by order for the different types of primes and in total

Response		Prime				Total
		SVO active	VOS active	SVO passive	VSO passive	
Active	SV(O)	0.816 (235)	0.81 (226)	0.813 (234)	0. 777 (227)	0.804 (922)
	VOS	0.073 (21)	0.082 (23)	0.059 (17)	0.058 (17)	0.068 (78)
	VSO	0.007 (2)	0.007 (2)	0.003 (1)	0.003 (1)	0.005 (6)
	VS	0.014 (4)	0.018 (5)	0.007 (2)	0.024 (7)	0.016 (18)
	OVS/OSV	0.007 (2)	0	0	0	0.002 (2)
Passive	SV(O)	0.083 (24)	0.079 (22)	0.111 (32)	0.127 (37)	0.1 (115)
	VSO	0	0.004 (1)	0.003 (1)	0.01 (3)	0.004 (5)
	VS	0	0	0.003 (1)	0	0.001 (1)
Total count		288	279	288	292	1147

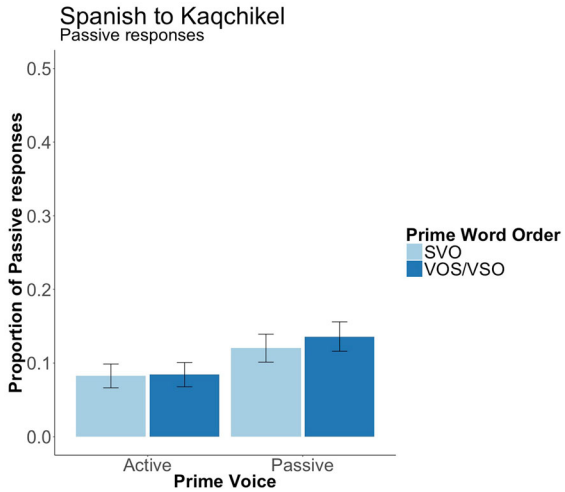

Fig. 3 Proportion of passive responses for the different type of primes in Experiment 2 (Spanish to Kaqchikel)

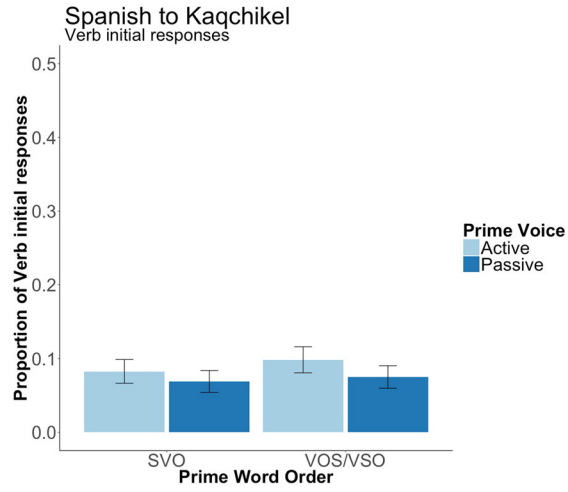

Fig. 4 Proportion of verb initial responses for the different type of primes in Experiment 2 (Spanish to Kaqchikel)

Further research is needed (with different pairs of languages) to be able to figure out which of these possibilities provides a better account of our results.

General discussion

In this work, we have presented two structural priming experiments: one within Kaqchikel, a Mayan language spoken in Guatemala, and one between Spanish and Kaqchikel. Kaqchikel is a VOS language that allows free word order variation, and Spanish (an SVO language) allows certain flexibility in word order as well. These features of both languages allowed us to test the role of word order flexibility in bilingual sentence production. In particular, it allowed us to test (1) whether word order alone can be primed in simple clauses, between and within languages; and (2) whether structural priming (in the form of voice priming) is hindered by word order variation even in highly flexible languages.

The results showed that there is priming of word order and of voice within Kaqchikel. Likewise, differences in word order did not have an effect in the proportion of passives, nor did voice have an effect in the proportion of verb initial sentences after their respective primes. These results point to an independence of structural planning and linear assembly

within Kaqchikel, such that previous exposure to a certain structure (in this case, passive sentences) increases the likelihood of producing that structure when structural planning is taking place; however, word order information is still not taken into account. On the other hand, exposure to a certain word order (in this case, verb initial sentences) increases the likelihood of choosing that very same order, regardless of the voice chosen for the sentence. That is, these results suggest that when word order is being selected in Kaqchikel, structural information does not play an essential role. These results on the independence of word order from structural function are consistent with previous work that shows word order priming *within* a language (Tanaka 2008; Hartsuiker and Westenberg 2000).

A more controversial issue is whether word order differences will block structural priming *between* languages, that is, whether or not structures with different word orders are connected between languages. Our results showed that there was no word order priming whatsoever between languages. Exposure to verb initial sentences in Spanish did not increase the likelihood of producing more verb initial sentences in Kaqchikel. However, importantly, priming of voice was present despite the differences in word order, suggesting that word order differences did not block structural priming. After listening to passive sentences in Spanish (in VSO and SVO orders), participants were more prone to produce passive sentences in Kaqchikel, *regardless* of the chosen word order. These results suggest that when word order is highly flexible, structural and linear representations are separately stored and/or are accessed at different moments in the sentence planning process. This results in connections between languages that are independent of word order.

These findings are in line with previous studies with Korean (Shin and Christianson 2009), an SOV language, that showed structural priming between Korean and English despite the basic word order differences between languages. Previous work (e.g. Bernolet et al. 2007) suggests that in languages like English or Dutch structural and linear representation are represented in a single node that is shared between languages. This is possibly the case given that these languages (1) share most of their word orders, with the exception of some structures, and (2) have a fixed word order in most of their structures. Thus, it is reasonable to conclude that, as a way to plan utterances in the most effective way, speakers will access both representations at the same time, simply because most of the times these two types of information go together.

This also is in line with monolingual sentence planning studies that assume flexibility in the way sentence planning takes place. Languages like English, where structural and linear mapping tend to match, are thought to rely on linear incremental planning (Gleitman et al. 2007) to a greater extent than languages with different word orders (e.g. Norcliffe et al. 2015; Kubo 2016). When word order varies, planning of both word order and structure at the same time it is sometimes not very efficient, and not even possible on occasion, which results in a greater reliance on structural incremental planning (Rodrigo et al. 2018). Thus, it is reasonable to think that the same flexibility that is observed in monolingual sentence planning is present in bilingual sentence production and, as an extension, in the interconnections between languages at the structural and linear levels.

Languages in which both word order and structural representations converge will more likely have a single representation that is shared between languages. However, as word order between languages differs, or as word order flexibility increases, this single representation becomes a less efficient way to plan utterances in both languages. As we noted when introducing Experiment 2, a structure-word order shared single node in a language like Kaqchikel would likely result in a different node for passive-SVO, passive-VSO and likely passive-OVS, with only some of them being shared with Spanish, which might convey an inefficient way of representation for this set of languages. Thus, Kaqchikel might be viewed as an extreme case that allows us to test the limits of flexibility: how are languages stored and accessed when any word order is possible?

We are aware that most languages do not allow such a wide array of word order variations. To our understanding, however, these results suggest that very much like monolingual sentence planning, bilingual sentence planning and representation move along a continuum between linear incremental planning with shared linear and structural representations, to highly structural incremental planning, with separate linear and structural representations. Monolingual sentence

planning studies also show that the way in which a language relies on structural or linear information varies with the demands of the task and the accessibility of lexical items or structural information (e.g. van de Velde et al. 2014; Konopka 2012). More studies are needed in order to test these hypotheses in bilingual sentence planning with online measures of the time-course of sentence planning, to test the parallelisms even further.

Interestingly, in our results we did not find cross-linguistic word order priming. While it is not possible to draw a firm conclusion from this lack of result, these results can suggest different possibilities to explore in further studies. These results could suggest a lack of connection at the linear level between languages. To our knowledge, there are no other studies that explore word order priming between languages regardless of structural variation. However, these data can also be explained in terms of differences in the topicalization of the structures at hand. As it was commented before, Spanish VOS/VSO orders are highly marked while Kaqchikel SVO order is considered to be the marked structure. It remains open whether these results are due to the low frequency of Spanish verb initial sentences. Studies with bilinguals of two highly flexible languages would allow to explore this issue in more detail.

We are aware that this is a rather limited study, with only priming in two directions: L1 to L1 (Kaqchikel to Kaqchikel) and L2 to L1 (Spanish to Kaqchikel), and with a limited number of participants. Despite its limitations, the results suggest a parallelism with monolingual sentence planning studies and an indication of the role that flexibility might play in determining which processes are prioritized when planning a sentence, and therefore, what kind of connections between languages are created. Future studies should explore bilinguals with languages of different word orders, and test all possible priming orders, as well as the role of word order in isolation.

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Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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