Interference of context and bilinguality with the word order preference in Kaqchikel reversible sentences

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Some inconsistent findings have been provided for word order preference in Kaqchikel, a language with the syntactically determined canonical word order of verb-object-subject (VOS): the canonical VOS is efficiently processed in sentence comprehension whereas the most frequent order is SVO in sentence production. In order to elucidate the nature of the discrepancy between comprehension and production in Kaqchikel, the present study utilized a sentence-picture matching task to compare the processing load for reversible transitive sentences with multiple animate entities (i.e., an animate subject and an animate object) among four possible word orders (VOS, VSO, SVO, and OVS). Results revealed that when an appropriate context was given, SVO was the most accurately and quickly processed order in Kaqchikel sentence comprehension, which does not agree with the results from existing research on sentence comprehension, where no context was provided. We further examined the influence of the individual native speakers' bilinguality in Spanish on the SVO preference in sentences with a context, indicating that those with a higher ratio of daily Spanish use quickly processed word orders in which the subject precedes the object (i.e., SVO and VSO). The native speakers' preference for VOS due to the syntactic canonicity seems to be overshadowed by the contextual factor and the bilinguality of the participants.

Key words: Picture-sentence matching, word order preference, Kaqchikel, animacy, bilinguality

Introduction

Verbalization of thought requires us to put words in a straight line. Word order is realized primarily based on the syntax of the particular language, but also to some degree by how individuals perceive the scene they are going to describe. Across the languages in the world, there exist many different realizations of syntactically determined canonical word order. Psycholinguists have provided abundant evidence that the word orders in which subject (S) precedes object (O) induce lower processing load than the opposite order of OS (e.g., Bader & Meng, 1999; Kaiser & Trueswell, 2004; Mazuka, Ito, & Kondoh, 2002; Sekerina, 1997; Tamaoka

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et al., 2005), which has led to what may be called the universal cognition theory (UCT): SO word orders are more efficient than OS word orders for sentence processing regardless of the basic word order of any individual languages (e.g., Bornkessel-Schlesewsky & Schlesewsky, 2009a, 2009b; Kemmerer, 2012; Tanaka, Branigan, McLean, & Pickering, 2011). However, those experimental studies supporting UCT have only focused on languages which have been assumed to have syntactically determined word order of SO, not OS. Recently, some attempts focusing on the Kaqchikel Maya language, whose syntactically determined basic word order is VOS (Kiyama, Tamaoka, Kim, & Koizumi, 2013; Koizumi et al., 2014), have added new evidence that VOS word order is processed faster and more accurately than SVO, supporting the individual grammar theory (IGT), rather than the UCT, that a language's syntactically determined basic word order has the lowest processing load among the grammatically possible word orders in that language (e.g., Gibson, 2000; Hawkins, 2004; Marantz, 2005; O'Grady, 1997; Pritchett & Whitman, 1995).

Kaqchikel is a Mayan language spoken in Guatemala. Like many other Mayan languages, Kaqchikel has a flexible word order. According to García Matzar and Rodríguez Guaján (1997) and others, Kaqchikel grammatically allows all the logically possible six word orders of subject, object, and verb. Among them, VOS is the syntactically basic word order, and SVO is also commonly used. SOV and OSV are rarely employed (Ajsivinac Sian, García Mátzar, Cutzal, & Alonzo Guaján, 2004; García Matzar & Rodríguez Guaján, 1997; Rodríguez Guaján, 1994; Tichoc Cumes et al., 2000). Although precise syntactic structures of Mayan languages are still under debate, for the purpose of the present study, it is sufficient to assume that for Kaqchikel transitive sentences with different word orders, the schematic syntactic structures are as shown in (1), in which VOS is structurally simpler than the other orders (cf. England, 1991; Tada, 1993; Koizumi et al., 2014; Yasunaga, Yano, Yasugi, & Koizumi, 2015).

(1) Order   Schematic syntactic structure
     VOS   [VOS]
     VSO   [[V gap$_i$ S] O$_i$]
     SVO   [S$_i$ [VO gap$_i$]]
     OVS   [O$_i$ [V gap$_i$ S]]

Since the word order alternation in modern Kaqchikel does not require any morphological transformation, animacy of noun phrases can yield reversible sentences (i.e., it makes sense when the semantic roles of the subject and the object are reversed if both the noun phrases are animate). Indeed, the effect of animacy seems to confound the word order preference in Kaqchikel. Although the VOS has been assumed to be the syntactically determined canonical word order in Kaqchikel and some psycholinguistic experiments utilizing sentence comprehension tasks have supported this assumption (Kiyama et al., 2013; Koizumi et al., 2014), a finding in terms of sentence production frequency (Kubo, Ono, Tanaka, Koizumi, & Sakai, 2015) provides counterevidence, i.e., that SVO is much frequently produced than VOS.

Further, it has also been noted that the SVO preference is more salient in reversible sentences with an animate subject and an animate object than in non-reversible ones with an animate subject and an inanimate object. Nevertheless, the VOS preference in comprehension has been found to be robust throughout reversible (Kiyama et al., 2013) and non-reversible (Koizumi et al., 2014) sentences.

The inconsistent findings of word order preference in reversible sentences between comprehension and production might come from a qualitative difference in their experimental procedures. During the sentence comprehension task employed by Kiyama et al. (2013) and Koizumi et al. (2014), participants listened to stimulus sentences with no prior context provided, so they did not have the entire picture of the given sentence's content until they listened to the last phrase. In the sentence production experiment by Kubo et al. (2015), on the other hand, participants were presented with a picture depicting either a transitive or intransitive event, and were asked to describe it with a Kaqchikel sentence. In other words, the sentence production task allowed the participants to use context, which might lead to topicalization, i.e., a preposing of the agent/subject of the sentence (García Matzar & Rodríguez Guaján, 1997; Tichoc Cums et al., 2000; Ajsivinac Sian et al., 2004). This might affect Kubo et al.'s (2015) result that SVO was much more frequent than VOS. As has been argued in the literature, syntactically determined canonical word order should be distinguished from "pragmatically determined word order" when considering Mayan languages (Brody, 1984; England, 1991).

A possible way to elucidate the nature of the discrepancy between comprehension and production in Kaqchikel is to use a task administering simultaneous presentation of visual and auditory stimuli, so that participants can listen to sentences with the entire picture of all the elements from the onset. Employing this procedure, the context provided might reduce the processing load of SVO sentences during comprehension.

Another confounding factor is in relation to bilinguality. Nowadays, most of the native Kaqchikel speakers are bilingual in Spanish, as this is inevitable in order for them to study at school or to engage in economic activities. As they get accustomed to speaking Spanish whose canonical word order is SVO, the preference for SVO in Spanish may affect the VOS preference in Kaqchikel (cf. England, 1991: 475).

Taken together, the present study compared the processing load for Kaqchikel reversible transitive sentences including multiple animate entities (i.e., an animate subject and an animate object) among four possible word orders of VOS, VSO, SVO, and OVS, with the effect of individual speaker's bilinguality as a covariate-of-interest. In order to elucidate the effect of the contextual factor, we employed a picture-sentence matching task where participants were simultaneously presented with auditory Kaqchikel reversible sentences and a picture denoting the scene of the given sentence.

Method

Participants

Sixty healthy native Kaqchikel speakers (37 females; age range: 18-60, M = 33.7, SD = 10.9) who lived in Guatemala participated in this experiment after giving their written informed consent. In order to assess individual degree of Kaqchikel-Spanish bilinguality, participants completed a questionnaire concerning their use of the two languages in daily life, which was originally created for this study. All of them were given remuneration for their participation. This experiment was approved by the ethical committee of the Graduate School of Arts and Letters, Tohoku University, Japan.

Materials

Materials for our picture-sentence matching task consisted of pictures depicting a transitive action with the agent(s) and patient(s), and the corresponding auditorily presented Kaqchikel transitive sentences, all of which were identical with the stimuli used by Yasunaga et al. (2015). In each picture, the agent(s) and patient(s) were painted in different colors, namely, *käq* "red," *xar* "blue," *säq* "white," and *q'ëq* "black." The transitive actions were depicted on the agent(s) and patient(s) to refer to one of the following six common transitive verbs in Kaqchikel: *jïk'* "pull," *xib'ij* "surprise," *nïm* "push," *pixab'aj* "bless," *oyoj* "call," and *ch'äy* "hit," as shown in Figure 1. In the present task, we set either the agent side or the patient side as plural, and the other as singular in order to identify the agent-patient relationship. Consequently, we prepared a total of 96 target stimulus pictures (i.e., 6 verbs × 4 colors × 2 agent/patient × 2 singular/plural). The assignment of left-right position of the agent(s) and patient(s) were counterbalanced across all the stimulus pictures.
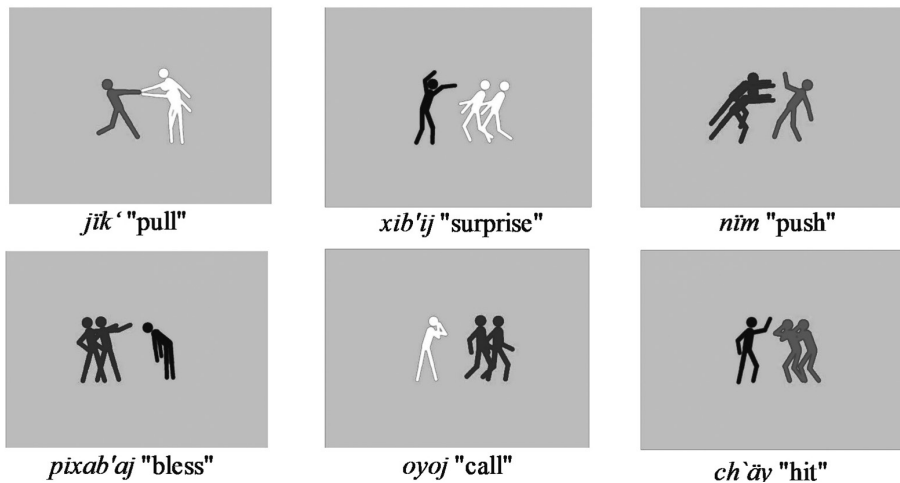

Figure 1. Examples of the stimulus pictures depicting a transitive action with the agent(s) and patient(s) used in the picture-sentence matching task. The pictures were shown in color in the actual experiment.

A total of 192 auditorily presented target sentences corresponding to the stimulus pictures were arranged into each of the four word orders of VOS, VSO, SVO, and OVS, as exemplified in (2). (The following abbreviations were used in this article: ABS [absolutive], CL [classifier], CP [completive], DET [determiner], ERG [ergative], pl [plural], sg [singular], 1 [first person], 3 [third person], PM [plural marker].)

(2) a. Xkoyoj/ri xar/ri taq käq. [VOS]
          CP-ABS3sg-ERG3pl-call/ DET blue/ DET PM red
          "The reds called the blue."
     b. Xkoyoj/ri taq käq/ri xar. [VSO]
     c. Ri taq käq/xkoyoj/ri xar. [SVO]
     d. Ri xar/xkoyoj/ri taq käq. [OVS]

All the target sentences included a definite animate subject, a definite animate object, and an action verb in past tense. In order to morpho-syntactically differentiate the agent-patient relationship, half of the sentences contained a singular subject and plural object, and the other half contained a plural subject and singular object. In addition, 96 filler sentences were prepared to allow participants to make judgments of the mismatch with the given pictures. Mismatch trials were created by reversing agent-patient relationship, changing color assignment, or indicating incorrect action. The sentences were recorded by a male native Kaqchikel speaker. The length of the duration of each sentence was trimmed such that differences were not induced across the four word orders. The details for the editing procedure are described in Yasunaga et al. (2015).

Procedure
    Participants were seated in front of a monitor, and asked to look at a fixation mark (+++) presented in the center of the monitor for 1000 ms before they were presented with the auditory transitive sentences through a headphone and the picture in the monitor simultaneously. They were instructed to indicate via button press whether the picture was congruent with the content of the given sentence, as quickly and accurately as possible. Before the experiment proper started, they were given 24 practice trials to learn the task. The volume was adjusted if needed. The experiment consisted of two blocks with a small break between them. At the beginning of each block, two warm-up trials were included. On an average, the whole procedure took approximately one hour. E-prime 2.0 (Psychology Software Tools, Pittsburgh, PA) was used for the stimulus presentation and behavioral data acquisition.

Analysis
    The present study aimed to compare processing load for four possible word orders of Kaqchikel reversible sentences, correlated with individuals' binguality in Spanish. For this purpose, we performed a linear mixed effects (LME) analysis (e.g., Baayen, 2008) with the maximum-likelihood method. This method estimates the effects of fixed variables (either

continuous or categorical) that are of interest in the study over random effects that can be assumed to be sampled at random from the population. To analyze the data of accuracy rate (ACC) and reaction time (RT), factors of Word Order (VOS, VSO, SVO, and OVS) and participants' self-evaluated Ratio of Spanish Use in daily life, which were collected from the questionnaire survey prior to the picture-sentence matching task, were entered as fixed variables. Among the four word orders, OVS was set as the reference condition in order to examine facilitation effects of other word orders in comparison with the least common order. Item and Participant were set as random variables. The RT data was trimmed at 2.5 standard deviations above the mean of each condition for each participant, and 1.7 % of all the data were changed. The model estimation was conducted using lme4 (Bates, Maechler, Bolker, & Walker, 2014) and lmerTest (Kuznetsova, Brockhoff, & Christensen, 2014) packages implemented in R version 3.3.0. The specified model was [ACC/RT ~ Word Order * Spanish Ratio + (1|Item) + (1|Participant)]. Multiple comparisons for subsets among the four conditions of the Word Order factor were performed with the step() function from the lmerTest package. The alpha level was set at .05 for all the statistical tests. All continuous variables (i.e., fixed variable of Spanish Ratio and dependent measures of ACC and RT) were centered and scaled before analysis to obtain standardized fixed-effect parameters (β).

Results

On average, ACC of the picture-sentence matching task (Figure 2) was the highest for SVO ($M = .967$, $SD = .180$), and the lowest for OVS ($M = .758$, $SD = .428$). Other orders of VSO ($M = .929$, $SD = .257$) and VOS ($M = .931$, $SD = .254$) were between the two. Mean RT of the task (Figure 3) were 3270 ms ($SD = 947$) for SVO, 3334 ms ($SD = 605$) for VOS, 3371 ms ($SD = 701$) for VSO, and 3590 ms ($SD = 550$) for OVS. In comparison with the most inaccurate and slowest OVS, other three word orders were processed more accurately (all $p < .001$ for ACC in Table 1) and faster (all $p < .001$ for RT in Table 2). The difference between SVO and VOS ($p < .01$ for ACC, $p < .05$ for RT) and that between SVO and VSO ($p < .01$ for ACC, $p < .001$ for RT) were also significant, whereas the difference between VSO and VOS did not reach the alpha level.
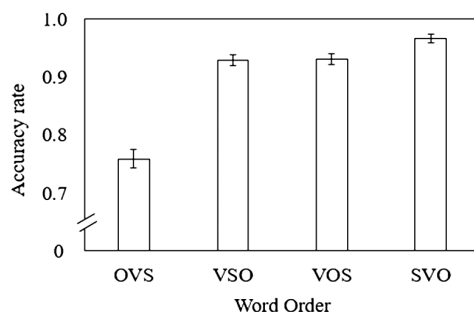
Figure 2. Accuracy rate of the picture-sentence matching task of Kaqchikel reversible sentences. Error bars indicate 95% confidence intervals. O: object; V: verb; S: subject.

Figure 3. Reaction time of the picture-sentence matching task of Kaqchikel reversible sentences. Error bars indicate 95% confidence intervals. O: object; V: verb; S: subject.
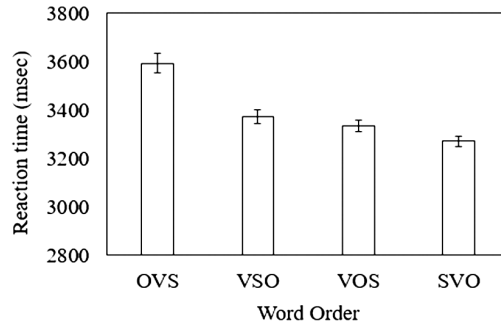
Table 1. Fixed effects of LME analysis on accuracy rate of the sentence-picture matching task in Kaqchikel reversible sentences

Contrast	Partial regression coefficient: β	t	p
(intercept)	.759 [.728, .789]	48.989	< .000
Word Order: VSO > OVS	.170 [.141, .199]	11.518	< .000
Word Order: VOS > OVS	.172 [.143, .201]	11.633	< .000
Word Order: SVO > OVS	.208 [.179, .237]	14.076	< .000
Spanish use	.027 [-.002, .056]	1.828	.070
Spanish use * VSO > OVS	-.002 [-.032, .027]	-0.159	.874
Spanish use * VOS > OVS	-.018 [-.048, .011]	-1.239	.216
Spanish use * SVO > OVS	-.025 [-.054, .005]	-1.658	.097

Note: Values in brackets denote 95% confidence intervals.

Table 2. Fixed effects of LME analysis on reaction time of the picture-matching task in Kaqchikel reversible sentences

Contrast	Partial regression coefficient: β	t	p
(intercept)	.307 [.149, .466]	3.835	< .000
Word Order: VSO > OVS	-.325 [-.417, -.233]	-6.941	< .000
Word Order: VOS > OVS	-.373 [-.465, -.281]	-7.975	< .000
Word Order: SVO > OVS	-.465 [-.556, -.374]	-10.017	< .000
Spanish use	.217 [.064, .370]	2.814	.006
Spanish use * VSO > OVS	-.106 [-.201, -.012]	-2.200	.028
Spanish use * VOS > OVS	-.077 [-.170, -.016]	-1.632	.103
Spanish use * SVO > OVS	-.139 [-.231, -.047]	-2.958	.003

Note: Values in brackets denote 95% confidence intervals.

Analysis with the LME modeling revealed the significant interaction between Word Order and Spanish Ratio on RT data. In comparison with the slowest OVS, participants with a

higher ratio of Spanish use in daily life processed faster for SVO (β = -.139, p < .05) and VSO (β = -.106, p < .01), but no significance was found for VOS (β = -.077, ns.) as shown in Table 2. The facilitation effect for SVO processing by Spanish-dominant participants is as plotted in Figure 4.
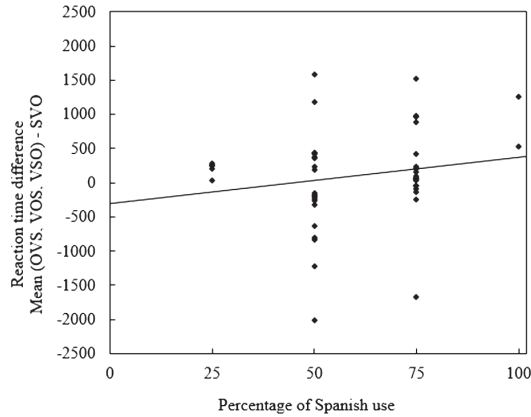

Figure 4. Plot between percentage of Spanish use and SVO preference in terms of the reaction time of a picture matching task in Kaqchikel sentences with animate objects (average among OVS, VOS, VSO minus SVO). O: object; V: verb; S: subject.

Discussion

Some inconsistent findings for word-order preference in the Kaqchikel language have been found, that is, the syntactically determined canonical order VOS is the most efficient order in sentence comprehension, whereas SVO is the most frequently used order in sentence production. In order to investigate the nature of this discrepancy, the present study re-examined word order preference in Kaqchikel reversible sentences with multiple animate entities, utilizing a picture-sentence matching task wherein participants listened to sentences with the picture depicting the scene presented at the onset. The findings obtained from the present study elucidate how native Kaqchikel speakers comprehend reversible sentences when they are given a context at the beginning of sentence processing, and to what extent those speakers' bilinguality in Spanish is correlated with the word order preference in their native language.

Results revealed that when a context was given with a picture denoting the scene of the sentence at the onset, SVO was the most accurate and quickly processed order in the comprehension of Kaqchikel reversible sentences. The finding is different from the previous findings of sentence comprehension tasks without any substantial context where the VOS order was preferred to SVO both in terms of behavior (Kiyama et al., 2013; Koizumi et al., 2014) and neural activity (Koizumi & Kim, 2016), but consistent with the result of a sentence production task, which provided a context by picture presentation in advance (Kubo et al., 2015), indicating that SVO was the most frequent order. An effect of context on word order

preference in Kaqchikel is now clearly demonstrated in sentence comprehension as a result of our picture-sentence matching task, which administered simultaneous presentation of auditory stimulus sentences and the corresponding pictures that showed all the elements which needed to be described in the sentence at the onset. Context seems to matter for determining the cognitive load for sentence processing, regardless of whether it is through comprehension or production.

The contextual factor is known to play a greater role in sentence processing of languages that allow flexible word orders to induce a particular motivation for the use of non-canonical orders (e.g., Kaiser & Trueswell, 2004, Koizumi & Imamura, 2016). Especially in Kaqchikel, SVO is frequently observed when the subject is topicalized, whereas VOS is assumed to be a syntactically canonical word order and can be used in a pragmatically neutral context (Ajsivinac Cian et al., 2004; García Matzar & Rodríguez Guaján, 1997; Tichoc Cumes et al., 2000). It has been universally demonstrated that subjects tend to have the property of salience for being easily topicalized in conversations and to appear at the beginning of sentences (e.g., Bornkesell, Schlesewsky, & Friederici, 2002). This is also the case for Kaqchikel, since the space for a topic is syntactically secure before verbs (Aissen, 1992; England, 1991; García Matzar & Rodríguez Guaján, 1997). Given the present finding of sentence comprehension with a context that the syntactically non-canonical SVO was processed more accurately and quickly than the syntactically canonical VOS, the "saliency of subject" effect has been demonstrated to be applied not just for sentence production, but also for sentence comprehension.

It should also be noted that the present study utilized reversible sentences with animate entities for the stimuli of the auditory presentation, that is, both the subject (i.e., agent) and the object (i.e., patient) were animate. This yielded a syntactic ambiguity in Kaqchikel sentence processing that the verb-initial orders of VOS and VSO cannot be distinguished without semantic clues, since no morphological transformations are required for word order alternation. Here is an interesting conflict between syntactic word order canonicity and conceptual accessibility. In Kaqchikel, the syntactically determined canonical word order is VOS, in which the subject comes at the end. In terms of conceptual accessibility, however, the subject should come earlier if it denotes the animate agent, because this idea assumes that the more easily accessible entity is the agent rather than the patient, and that the agent is typically animate while the patient is not necessarily the case (Bock & Warren, 1985). Further, if the subject (agent) and the object (patient) are reversible (e.g., both are animate entities), the motivation for the subject to precede the object should be facilitated so that the agent-patient relationship is clarified earlier than otherwise.

Kubo et al. (2015) examined the similarity-based competition in Kaqchikel sentence production, supporting the assumption that the easily accessible animate agent comes earlier particularly in reversible sentences: The production frequency of the syntactically canonical VOS was lower in reversible sentences (i.e., both of the subject/agent and the object/patient were animate; 8.3%) than in non-reversible sentences (i.e., the subject/agent was animate and the object/patient was inanimate; 28.5%), while SVO was the most frequent order throughout all the sentence types (always more than 70%). The present study of sentence comprehension

with a context replicated Kubo et al.'s (2015) finding, that in reversible sentences with animate entities, the subject-initial order (SVO) was the most accurate and fastest, and the non-canonical order of VSO in which the subject precedes the object was facilitated enough to be processed as accurately and as quickly as the syntactically canonical order of VOS, in which the subject comes at the end.

The preference for the subject denoting animate agent to precede the object of animate patient in Kaqchikel sentence processing seems to interfere with individual native speakers' bilinguality in Spanish. The analysis with LME modeling indicated that in comparison with the least common order of OVS, the reaction time of word orders in which the subject precedes the object (i.e., SVO and VSO) was shorter for participants with a higher ratio of daily Spanish use. However, the effect was not found in the comparison between the orders of VOS and OVS in which the object precedes the subject. Given that prolonged exposure to the second language has influences on information processing in the first language (e.g., Marian & Spivey, 2003), our Kaqchikel speaking participants' familiarity with the canonical order of SVO in Spanish may partially underlie the causes for their processing of the syntactically canonical VOS being inhibited in the present picture-sentence matching task. The finding that individual native Kaqchikel speakers' bilinguality in Spanish facilitates the SVO preference even in sentence comprehension (not just in production) implies that the syntactically assumed VOS canonicity could possibly be replaced by the frequently used SVO diachronically, as the use of Spanish is overwhelming among the current Kaqchikel speaking society. It should be noted at this point, however, that this does not mean that the grammatical system of Kaqchikel has shifted completely so that the syntactically determined basic word order of the present day Kaqchikel is SVO rather than VOS. As convincingly demonstrated in Yasunaga et al. (2015) and Yano, Yasunaga, and Koizumi (in press), the word order associated with the simplest syntactic structure in Kaqchikel is still VOS, and the other word orders are syntactically more complex involving a filler-gap dependency, as schematically shown in (1) above. Thus, the results of the experiment reported here should be interpreted in such a way that the effect of context and bilinguality on sentence processing load was larger than the effect of syntactic factors.

Although our picture-sentence matching task has provided an insight into the word order preference in sentence processing of languages with object-preceding word orders, the present study has certain limitations, some of which may be inevitable especially when dealing with an endangered language. The index of daily Spanish use utilized as a covariate for our analysis was not standardized, but based on the participants' own subjective evaluations. The reported percentage of daily Spanish use varied limitedly between .25, .50, .75, and 1, which might somewhat obscure the plotted individual difference of bilinguality. We had to rely on this weak index due to the fact that evaluation guidelines of linguistic ability have not been established in Kaqchikel, although it is available in Spanish. Difficulties are inherent in the standardization of assessment of bilinguality between an endangered language and its dominant counterpart because endangered languages are typically only spoken, and have

small vocabularies (because of loanwords) and no (widely used well standardized) orthography. Future research should address the need for the development of a validated evaluation method for endangered languages to better understand the bilingual language interactions in word order preference.

Conclusion

The current study utilizing a sentence-picture matching task concludes that context facilitates Kaqchikel native speakers' processing of reversible SVO sentences, and that the facilitation effect is enhanced in those with a higher ratio of daily Spanish use. The prolonged exposure to the canonical order of SVO in Spanish may interfere with the syntactic canonicity of VOS inherent in native Kaqchikel speakers.

Acknowledgments

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