

# Effect of Animacy on Word Order Processing in Kaqchikel Maya

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This study investigated the processing load of transitive sentences in two different basic word orders (i.e., VOS and SVO) in Kaqchikel Maya, with a particular focus on the animacy of the object. The results of a sentence plausibility judgment task showed that VOS sentences were processed faster than SVO sentences regardless of the animacy of the object. This supports the traditional analysis in Mayan linguistics that, although SVO is the most frequently used word order, the syntactically determined basic word order is VOS in Kaqchikel, as in many other Mayan languages. More importantly, the results suggest that the processing load in Kaqchikel sentence comprehension is more strongly affected by syntactic canonicity than production frequency or object animacy.

*Keywords:* Animacy; Sentence Processing; SO Word Order Preference; Syntax; Kaqchikel

## Introduction

According to experimental findings from languages such as Basque, English, Finnish, German, and Japanese, sentences in which the subject (S) precedes the object (O) (SO word order = SOV, SVO, VSO) induce a lower processing load for comprehension than those in which the opposite occurs (OS word order = OSV, OVS, VOS), and thus, they are preferred by speakers (Bader & Meng, 1999; Erdocia et al., 2009; Kaiser & Trueswell, 2004; Mazuka, Itoh, & Kondo, 2002; Sekerina, 1997; Tamaoka et al., 2005; Tamaoka et al., 2013; among many others). However, these previous studies on sentence processing have all targeted languages in which the subject precedes the object in syntactically basic word orders (i.e., SO languages). Hence, it remains unclear whether the preference for SO is a reflection of word order in individual languages or more universal human cognitive features. What we refer to as individual grammar theory in this paper posits that a language's syntactically determined basic word order has a low processing load in comparison with other possible word orders (e.g., Gibson, 2000), whereas what may be referred to as universal cognition theory hypothesizes that SO word order has a low processing load regardless of the basic word order of any individual language (e.g., Bock & Warren, 1985). To verify which of these two theories is correct, it is necessary to examine languages in which the object precedes the subject in syntactically basic word orders (i.e., OS languages), for which the two theories develop different predictions.

Koizumi et al. (under review) conducted a sentence-processing experiment in Kaqchikel, a Mayan language spoken in Guatemala. The syntactically determined basic word order of Kaqchikel is VOS, although in general, word order is relatively flexible (García Matzar & Rodríguez Guaján, 1997: p. 333).

They found that VOS was processed faster than the two other commonly used word orders, VSO and SVO. This suggests that the preference for SO in sentence comprehension is not universal; rather, syntactic features of individual languages significantly influence sentence processing load. In other words, the individual grammar theory, rather than the universal cognition theory, was supported.

It is interesting to note at this point that the production frequency of SVO is higher than that of VOS in Kaqchikel: SVO (74.4%) vs. VOS (24.2%), according to Kubo et al. (2012). The production frequency factor, therefore, should facilitate the processing of SVO compared to VOS. The syntactic complexity and frequency of usage presumably work in the opposite direction: the syntax favors VOS, whereas the frequency favors SVO. The former overwhelms the latter, resulting in the lower processing load of VOS. A confounding factor here has to do with the animacy of the object. In Kaqchikel, SVO order is more frequently used when the object denotes an animate entity such as a human, compared to when the object is inanimate: SVO (87.1%) vs. VOS (12.9%) with animate objects; SVO (60.9%) vs. VOS (39.1%) with inanimate objects (Kubo et al., 2012). The target sentences used in Koizumi et al.'s (under review) experiment all have an object denoting an inanimate entity such as a book. Thus, it is possible that VOS was processed faster than SVO in their experiment because they used sentences with inanimate objects, for which the difference between VOS and SVO, in terms of production frequency, is relatively small. In other words, SVO sentences might be processed faster than VOS sentences if the object is animate, in which case the difference in production frequency between VOS and SVO is much greater. To test if this is indeed the case, we conducted an auditorily presented sentence plausibility judgment task (e.g., Caplan, Chen, & Waters, 2008).

## Kaqchikel

Kaqchikel is 1 of the 21 Mayan languages spoken in Guatemala. It is mainly used in the highlands west of Guatemala City, the capital. With over 450,000 speakers, it is one of the principal Mayan languages along with K'iche', Q'eqchi', and Mam (Brown, Maxwell, & Little, 2006: p. 2; Lewis, 2009; Tay Coyoy, 1996: p. 55).

Like other Mayan languages, Kaqchikel is head marking: subjects and objects are unmarked, and person and number agreement for both subjects and objects are obligatorily expressed on the verb. Kaqchikel is ergative, like other Mayan languages. In Mayan linguistics, ergative agreement markers (i.e., those that indicate the subject of a transitive verb) are called Set A, and absolutive agreement markers (which indicate either the subject of an intransitive verb or object of a transitive verb) are known as Set B. The order of morphemes in the verb is [Aspect-B-A-Verb stem]<sup>1</sup>. An example is given in 1) below.

- 1) *Y-e'-in-to'*  
IC-B3PL-A1SG-help  
"I help them."

Since Kaqchikel is a pro-drop language, 1) functions as both independent speech and an independent sentence.

Like its ancestor language, Kaqchikel's syntactically determined basic word order is VOS, but SVO and VSO are also possible (Rodríguez Guaján, 1994: p. 200; García Matzar & Rodríguez Guaján, 1997: p. 333; Tichoc Cumes et al., 2000: p. 195; Ajsivinac Sian et al., 2004: p. 162). According to England (1991), these word orders are derived from VOS through reordering rules, as schematically shown in 2)<sup>2</sup>.

2) Order	Derivation
VOS	[VOS]
VSO	[[V__S] REORDERED O]
SVO	[REORDERED S [VO__]]

Aissen (1992) has proposed more elaborate syntactic structures for Mayan sentences with these word orders, but her analysis agrees with England's in that VSO and SVO word orders are associated with more complex syntactic structures than VOS word order (see also Coon, 2010; Preminger, 2011).

Given this feature, the following predictions can be made about processing load in the comprehension of Kaqchikel sentences: if the preference for SO word order shown by speakers of SO languages is mainly caused by the syntactic structure of the individual language, as suggested by the individual grammar theory, VOS sentences should have a lower processing load than VSO or SVO sentences in Kaqchikel. On the other hand, if SO triggers a lower processing load than OS regardless of the basic word order of the individual grammar, as suggested

by the universal cognition theory, then Kaqchikel VOS sentences should create a greater processing load than the other two word orders. Koizumi et al. (under review) conducted a sentence-processing experiment to test these predictions. The results of the experiment revealed that for Kaqchikel speakers, the processing load of VOS is lower than that of the two other commonly used word orders, VSO and SVO.

As mentioned in the previous section, however, the production frequency of SVO is higher than that of VOS in Kaqchikel. Furthermore, SVO order is more frequently produced when the object denotes an animate entity such as a human, compared to when the object is inanimate: SVO (87.1%) vs. VOS (12.9%) with animate objects; SVO (60.9%) vs. VOS (39.1%) with inanimate objects (Kubo et al., 2012). The target sentences used in Koizumi et al.'s (under review) experiment all have an inanimate object. Thus, it is possible that VOS was processed faster than SVO in their experiment because they used sentences with inanimate objects, for which the difference between VOS and SVO, in terms of production frequency, is relatively small. In other words, SVO sentences might be processed faster than VOS sentences if the object is animate, in which case the difference in production frequency between VOS and SVO is much greater. To test this idea, this study conducted a sentence plausibility judgment task to evaluate the effect of object animacy on sentence processing load in Kaqchikel Maya.

## Method

### Participants

A total of 53 Kaqchikel native speakers who live in Guatemala (28 males; mean age  $\pm$  SD = 34.7 years  $\pm$  10.6) gave their written, informed consent to participate in the research. Because of considerable dialectal and idiolectal variation among Kaqchikel speakers, the data of participants who had less than 80% accuracy in the experiment were excluded, leaving the data of 24 participants in the final analysis.

### Materials

Semantically natural, grammatical transitive sentences were arranged into each of the two word orders (VOS and SVO), as shown in 3). Eighty pairs, for 160 target sentences, were created in this way. Forty pairs of sentences among the 80 pairs had an animate object, and the remaining 40 pairs had an inanimate object. The subject was always animate.

- 3) a. [VOS]  
*X-e-ru-pis ri taq lej ri ch'uitata'*  
CP-B3PL-A3SG-wrap DET PM tortilla DET uncle  
"The uncle wrapped the tortillas."  
b. [SVO]  
*Ri ch'uitata' X-e-ru-pis ri taq lej*  
DET uncle CP-B3PL-A3SG-wrap DET PM tortilla

Among the 80 sentence pairs, the number of letters did not differ significantly between subjects ( $M = 10.2$  letters,  $SD = 2.0$  letters) and objects ( $M = 9.7$  letters,  $SD = 2.0$  letters) ( $t_{79} = 1.61$ ,  $p = .11$ , *ns.*). Representative examples along with their English translations are shown in the Appendix.

Additionally, 40 transitive sentences that were grammatical but not semantically natural were arranged in each of the two

<sup>1</sup>The following abbreviations are used in this paper. IC [Incomplete], CP [complete], A [Set A ergative], B [Set B absolutive], 3 [third person], SG [singular], PL [plural], DET [determiner], PM [plural marker for nouns].

<sup>2</sup>All six word orders that are logically possible are indeed allowed in many of the Mayan languages, including Kaqchikel (England, 1991; García Matzar & Rodríguez Guaján, 1997: p. 333). SVO in particular is most frequently used. It has been suggested that this is due to the influence of Spanish (Maxwell & Little, 2006), but the fact that all six word orders, including SVO, appear in 16th-century Kaqchikel texts shows that SVO was used before the language had contact with Spanish (Rodríguez Guaján, 1989 quoted in England, 1991; García Matzar & Rodríguez Guaján, 1997: p. 334).

word orders. They were semantically implausible mostly because of selectional restriction violations (e.g., #*Xuch'äj ri kaq'iq' ri xta Selfa* "Miss Selfa washed the air"). All 120 sentence pairs, consisting of 240 sentences, were counterbalanced and then categorized into two groups according to word order. Further, 192 filler sentences were added to each group. All the stimulus sentences were recorded by a male native Kaqchikel speaker and saved as WAV sound files.

The duration of each of the recorded semantically plausible sentences was trimmed in Praat ver. 5.1.31 (Boersma, 2001) to reduce the difference between the VOS and SVO sentences within each pair as much as possible. The trimming was done by slightly shortening the duration of some pauses between phrases. The difference between the duration of VOS sentences ( $M = 3274$  ms,  $SD = 299$ ) and that of SVO sentences ( $M = 3274$  ms,  $SD = 299$ ) was not significant ( $t_{79} = .130$ ,  $p = .897$ , *ns.*). All the trimmed sentences were judged as natural in terms of prosody by our native Kaqchikel consultants.

## Procedure

The participants listened to the stimulus sentences in a random order through headphones. They were asked to judge whether each sentence was semantically plausible and to answer by pushing a YES button (correct sentence) or NO button (incorrect sentence), as quickly and accurately as possible. The time from the beginning of each stimulus sentence until the button pressing was recorded as the reaction time. E-Prime ver. 2.0 (Psychology Software Tools) was used for presenting the stimuli and obtaining the behavioral data.

## Analysis

Among the 80 pairs of semantically plausible sentences, only items that were correctly judged by each participant were analyzed. Reaction times ranged from 1223 ms to 7635 ms, and all of them were within 2.5 standard deviations at both the high and low ranges from the individual mean of each participant in each category. Statistical analyses were conducted using a linear mixed effects (LME) model (e.g., Baayen, 2008) based on the restricted maximum-likelihood method (REML), which estimates the effects of fixed variables that are of interest in the study over random effects that can be assumed as being randomly sampled from the population. In this study, we assumed the word order of sentences (i.e., VOS vs. SVO) and animacy of the object (i.e., animate vs. inanimate) as fixed variables, and participant and item (i.e., stimulus sentence) as random variables. PASW ver. 18.0J (SPSS, Inc., 2008) was used to conduct the analysis.

## Results

**Table 1** shows the means and standard deviations of accuracy rates for the 80 sets of semantically plausible transitive sentences in the VOS and SVO word orders with animate and inanimate objects. The LME analysis indicated that both fixed effects of the word order ( $F_{1, 936} = .354$ ,  $p = .552$ , *ns.*) and object animacy ( $F_{1, 1032} = 1.690$ ,  $p = .194$ , *ns.*) were not significant. The interaction effect of the two variables was not significant either ( $F_{1, 933} = .174$ ,  $p = .677$ , *ns.*).

**Table 2** shows the means and standard deviations of reaction times for the correctly judged semantically plausible target sentences. The same analysis revealed that the fixed effect of

**Table 1.**

Accuracy rates (%) of sentence plausibility judgment for Kaqchikel VOS and SVO sentences with animate and inanimate objects.

	Animate object		Inanimate object	
	<i>M</i> (%)	<i>SD</i> (%)	<i>M</i> (%)	<i>SD</i> (%)
VOS	79.6	40.4	81.7	38.8
SVO	77.1	42.1	81.3	39.1

**Table 2.**

Reaction times (ms) of sentence plausibility judgment for Kaqchikel VOS and SVO sentences with animate and inanimate objects.

	Animate object		Inanimate object	
	<i>M</i> (ms)	<i>SD</i> (ms)	<i>M</i> (ms)	<i>SD</i> (ms)
VOS	3856	597	3839	715
SVO	3911	585	3964	706

word order was significant ( $F_{1, 741} = 4.983$ ,  $p < .05$ ). The fixed effect of object animacy ( $F_{1, 741} = .040$ ,  $p = .842$ , *ns.*) and the interaction effect of the two variables ( $F_{1, 740} = .692$ ,  $p = .406$ , *ns.*) were not significant. The results indicated that the difference of reaction times (91 ms) between VOS sentences ( $M = 3847$  ms,  $SD = 658$  ms) and SVO sentences ( $M = 3938$  ms,  $SD = 650$  ms) was significant, regardless of the object animacy.

## Discussion

In order to explore the processing load of transitive sentences in two commonly used word orders (i.e., VOS and SVO) in Kaqchikel Maya with reference to the animacy of the object, this study conducted an experiment with a sentence plausibility judgment task. The results of the LME analysis showed that VOS was processed faster than SVO regardless of the animacy of the object. That is, although SVO is more frequently produced when the object is animate compared to when the object is inanimate, the sentence processing load is not significantly affected by this difference. Rather, syntactic features play a more prominent role in sentence processing, a conclusion consistent with the individual grammar theory.

A question naturally arises as to why SVO is more frequently used when the object is animate compared to when it is inanimate, even though the animacy of the object does not affect the processing load<sup>3</sup>. We suggest that this is because the choice of SO vs. OS order in sentence production is primarily determined by conceptual factors at earlier stages of sentence production (Bock et al., 1985; Tanaka et al., 2011) without regard to the overall computational load, which is also strongly affected by processes in subsequent stages such as the construction of syntactic structures. In particular, we agree with Kubo et al. (2012) that similarity-based competition is the key factor here.

Gennari et al. (2012) argues that when there is a temporal overlap in the planning of two conceptually similar nouns, the similarity leads to interference between the semantic information of the nouns. As a result, when the concept of one noun is activated, the concept of the other noun is inhibited, and the latter noun is mentioned away from the initially activated noun, or simply omitted in the sentence. Moreover, the effect of con-

<sup>3</sup>This question is related to but different from the question of why SVO is more frequently used than VOS, the syntactically basic word order, in Kaqchikel. For a discussion of the latter, see Koizumi et al. (under review).

ceptual similarity interacts with language-specific grammatical constraints, and the actual instantiation may vary across languages. Kubo et al. (2012) examined how similarity-based competition influences speakers' choices of sentence patterns in Kaqchikel. The production of VOS sentences is interesting because the most accessible element, an animate agent noun usually realized as the subject, must be retained in memory until the end of the sentence, and hence, it potentially competes with other elements. If similarity-based competition arises between the subject and object in Kaqchikel, one of them must be realized away from the other. Since the object usually follows the verb in Kaqchikel, the increase of competition would lead to the decrease of VOS word order. Kubo et al. conducted two picture description experiments to verify this prediction. In the first experiment, the animacy of the patient noun was manipulated (human, animal, inanimate object) such that similarity between the agent (human) and patient varied among conditions. The results showed that VOS sentences were produced more often with an inanimate patient than with an animal or human patient, as predicted by similarity-based competition. In the second experiment, the researchers examined the effect of an agreement morpheme on the verb by changing the number of the object noun. The results replicated the overall patterns of the first experiment. That is, VOS sentences were produced more often with an inanimate patient than with a human patient, even when the number of the subject was different from the number of the object. This indicates that ambiguity resolution is not the most influential factor of the choice of sentence pattern in Kaqchikel. Putting the results together, native Kaqchikel speakers seem to be sensitive to the competition caused by the similarity of noun concepts involved in an event described in the sentence. Native Kaqchikel speakers select the sentence pattern in order to resolve competition between nouns with similar concepts.

## Conclusion

In Kaqchikel Maya, VOS word order is more frequently employed when the object is inanimate than when it is animate. The results of the listening comprehension experiment reported here show that VOS is processed faster than SVO regardless of the animacy of the object. This suggests that the processing load is not significantly affected by the animacy of the object in Kaqchikel.

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## Appendix

The followings are representative examples excerpted from the 80 semantically natural, grammatical transitive Kaqchikel sentences (target stimuli) and their English translations. They are presented in the word order of VOS in this Appendix.

1) Sentences with a plural inanimate object and a singular animate subject:

- a) *X-e-ru-pis* *ri taq lej*  
 CP-B3PL-A3SG-wrap DET PM tortilla  
*ri ch' utitata'*  
 DET uncle  
 "The uncle wrapped the tortillas."

- b) *X-e-ru-nim* *ri taq wuj*  
 CP-B3PL-A3SG-push DET PM book  
*ri malka'n.*  
 DET widow  
 "The widow pushed the books."

2) Sentences with a singular inanimate object and a plural animate subject:

- a) *X-φ-ki-jiq'aj* *ri jub'ül pom*  
 CP-B3SG-A3PL-breath DET fragrant incense  
*ri taq ajawa'.*  
 DET PM man  
 "The men breathed the fragrant incense."

- b) *X-φ-ki-chäq* *ri chäq' tz'o'*  
 CP-B3SG-A3PL-grind DET mature boiled corn  
*ri taq atita'*  
 DET PM grandmother  
 "The grandmothers grinded the mature boiled corn."

3) Sentences with a plural animate object and a singular animate subject:

- a) *X-e-ru-kajij* *ri taq yuq'iy b'aq*  
 CP-B3PL-A3SG-annoy DET PM bone-setter  
*ri cholonel.*  
 DET speaker  
 "The speaker annoyed the bone-setters."

- b) *X-e-ru-q'etej* *ri taq rach'alal*  
 CP-B3PL-A3SG-embrace DET PM family  
*ri b'iyinel*  
 DET walker  
 "The walker embraced the families."

4) Sentences with a singular animate object and a plural animate subject:

- a) *X-φ-ki-köl* *ri achijilom ri taq ixjayilom*  
 CP-B3SG-A3PL-save DET husband DET PM wife  
 "The wives saved the husband."

- b) *X-φ-ki-k'uxlaj* *ri kib'aluk*  
 CP-B3SG-A3PL-recall DET brother-in-law  
*ri taq rijitaq*  
 DET PM elderly  
 "The elderlies recalled the brother-in-law."