1 Introduction

Over seven thousand languages are currently in use on this planet (Eberhard, Simons, and Fennig (Eds.) 2020). Since the nineteenth century, descriptive and theoretical linguistic research has consistently increased the range of languages (their numbers and types) it covers as research subjects. It continues to contribute toward elucidating the universality and individuality of human languages. The growing body of theories in the latter half of the twentieth century, such as generative grammar (Chomsky 1957), linguistic typology (Greenberg 1963), and cognitive linguistics (Langacker 1987), accelerated this process of elucidation.

Meanwhile, as for the processing procedure and neural basis of language in the brain, psycholinguistic research with English as its subject of study became popular after the so-called cognitive revolution of the 1950s. By the 1980s, the subject of study expanded to languages other than English, such as German and Japanese. Then, in the 1990s, advanced technologies such as magnetic resonance imaging (MRI) and magnetoencephalography (MEG) to measure brain function came into practical use, which stimulated research into the neural basis of language. However, research involving psycholinguistics and neurolinguistics, which utilize behavioral testing and functional brain measurements, has until now mainly been conducted in laboratories of some developed nations due to economic, political, technical, and other restraints. Therefore, the selection of subject languages for research is extremely biased toward those spoken in rich countries and regions (Anand, Chung, and Wagers 2011; Norcliffe, Harris, and Jaeger 2015, among others). According to Anand, Chung, and Wagers (2011), one-third of all major psycholinguistic research conducted in the world studies English, and only ten languages account for 85 percent of the research. Only fifty-seven languages have ever been the subject of these studies, including those that have been covered only once. Most of these are Indo-European languages and are so-called Subject-before-Object (SO) languages (languages where the subject precedes the object as the basic word order). As a result, many current theories of psycholinguistics and linguistic neuroscience fail to acknowledge the nature of Object-before-Subject (OS) languages (languages where the object precedes the subject as the basic word order) and treat the nature of SO languages as though it is universal to the human language. A detailed consideration of language processing stages of more diverse languages and their neural bases is essential to elucidate the universality and individuality of human language processing, as well as the full cognitive function that controls language and thought.

The research reported in this book is an attempt to fill in the gap through a series of behavioral and neuroimaging experiments on Kaqchikel Maya, an endangered OS language spoken in Guatemala, with special reference to constituent order in language and thought. It is part of a larger project, the FALCOHN (Field-Based Approaches to Language, Cognition, and Human Nature) project, which investigates other rarely studied languages from various perspectives.

1.1 Word Order Preference

Human languages differ from one another in many respects, such as phonemes, syllable structures, case-marking, basic word order, and grammatically possible word orders. The word order in some languages, such as English, is relatively fixed, while other languages, such as Japanese, allow for some variation. In many languages with flexible word orders, sentences with a transitive verb (V) in which the subject (S) precedes the object (O) (SO word orders: SOV, SVO, VSO) have been reported to have a processing advantage over sentences in which S follows O (OS word orders: OSV, OVS, VOS) (Bader and Meng 1999 for German; Kaiser and Trueswell 2004 for Finnish; Kim 2012 for Korean; Mazuka, Itoh, and Kondo 2002 and Tamaoka et al. 2005 for Japanese; Sekerina 1997 for Russian; Tamaoka et al. 2011 for Sinhalese).[1] In Japanese, for example, the SOV word order, as exemplified in (1a), is processed faster than the OSV word order, as in (1b), according to various psycholinguistic studies using sentence plausibility judgment tasks (Chujo 1983; Tamaoka et al. 2005), self-paced reading (Koizumi and Imamura 2016; Shibata et al. 2006), and eye tracking (Mazuka, Itoh, and Kondo 2002; Tamaoka et al. 2014).

(1) a. Naomi ga suika o kitta. [SOV]
Naomi NOM watermelon ACC cut
"Naomi cut the watermelon."
b. Suika o Naomi ga kitta. [OSV]
watermelon ACC Naomi NOM cut

Neurolinguistic studies have also shown a similar SO processing preference. Functional magnetic resonance imaging (fMRI) studies have found a greater activation at the left inferior frontal gyrus (IFG) in the processing of OS word orders compared to SO word orders (Grewe et al. 2007 for German; Kim et al. 2009 and Kinno et al. 2008 for Japanese). Furthermore, studies with event-related potentials (ERPs) have revealed that, relative to SO word orders, OS word orders elicit a late positivity effect called P600 and/or (sustained) anterior negativity (Erdocia et al. 2009 for Basque; Rösler et al. 1998 for German; Hagiwara et al. 2007 and Ueno and Kluender 2003 for Japanese).

This SO preference has also been observed in sentence production, as SO orders are more frequently used than OS orders. For instance, Imamura and Koizumi (2011) report that, among Japanese transitive sentences with a nominal subject and a nominal object in the corpus of novels they studied, more than 97 percent had the SOV word order. This shows that, although Japanese is said to be "a free word order language" or "a flexible word order language," the SO order is strongly preferred to the OS order in sentence production. Higher rates of SO-ordered utterances have been reported in many other flexible languages as well (Slobin and Bever 1982 for Turkish and Serbo-Croatian; Hakulinen and Karlsson 1980 for Finnish; Bates 1976 for Italian).

A similar SO order preference has also been observed in rigid word order languages. In English, for example, object-extracted relative clauses such as (2b), in which the object precedes the subject, take longer to process and incur a higher left IFG activation than subject-extracted relative clauses such as (2a), in which the subject precedes the object (Caplan, Stanczak, and Waters 2008; King and Just 1991; Traxler, Morris, and Seely 2002; Wanner and Maratsos 1978; among many others).

(2) a. Subject-extracted relative clause (SO order)
[The lawyer that irritated the banker] filed a hefty lawsuit.

b. Object-extracted relative clause (OS order)
[The lawyer that the banker irritated] filed a hefty lawsuit.

Taken together, abundant evidence supports the claim that SO word orders are preferred to OS word orders in many of the world's languages.

1.2 Origins of Word Order Preference

The observations in the previous section bring up the question of why SO word orders should be preferred in sentence comprehension and production, along with the related empirical question of whether this preference is universal across all human languages. In the literature, a number of factors have been proposed that may affect word order preference in sentence comprehension and production.

1.2.1 Individual Grammar View

Many of the previous statements about word order preference can be classified under what we call the Individual Grammar View (IGV), which claims that SO preference is attributed to the grammatical factors of individual languages, such as syntactic complexities. According to the IGV, therefore, studies have found an SO word order preference because they have targeted SO languages.

Within each individual language, word orders beyond the syntactically basic one are derived from it through syntactic operations such as scrambling, which induces syntactic complexities. The IGV hypothesizes that a syntactically determined basic SO word order in a language is favored over other available word orders because derived OS word orders require the processing of more complex syntactic structures (see Gibson 2000; Hawkins 2004; Laka and Erdocia 2012; Marantz 2005; O'Grady 1997; Pritchett and Whitman 1995; among others). Consider the Japanese examples in (1) again, repeated here as (3).

(3) a. Naomi ga suika o kitta. [SOV]
Naomi NOM watermelon ACC cut
"Naomi cut the watermelon."

b. Suika o Naomi ga kitta. [OSV]
watermelon ACC Naomi NOM cut

Boldly simplifying for expository purposes, the sentences in (3a) and (3b) have mental representations like (4a) and (4b), respectively. Linguistic representations like these are called syntactic structures.

(4) a. $[_S$ [Naomi ga] $[_{VP}$ [suika o] kitta]] [SOV]
Naomi NOM watermelon ACC cut

b. [[suika o]$_i$ $[_S$ [Naomi ga] $[_{VP}$ t_i kitta]] [OSV]
watermelon ACC Naomi NOM cut

In (4a), the object *suika o* "watermelon ACC" and the verb *kitta* "cut" are grouped together to form a verb phrase (VP), which in turn is merged with the subject *Naomi ga* "Naomi NOM" to constitute a sentence. In (4b), the object has been dislocated to the head of the sentence and is grammatically associated with the phonetically empty category in the original object position, indicated by the symbol *t*. In the linguistic literature, a dislocated element like this is called an antecedent, and the associated empty category is called a trace, hence the symbol *t*. For convenience, a subscript (such as $_i$ in (4)) is used to indicate which antecedent corresponds to which trace. In psycholinguistics, the terms "filler" and "gap" are used more frequently than "antecedent" and "trace" to refer to the dislocated element and its associated empty category, respectively. Note that the syntactic structure in (4b) is more complex than the one in (4a) because the former contains a filler-gap dependency and the latter does not. Thus, when processing a sentence like (3b), the parser must associate the filler with the corresponding gap, which requires additional computational steps that are not needed in the processing of a sentence like (3a). According to a version of the IGV, this is why (3b) is more difficult to process than (3a).

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English relative clauses such as those in (2), both subject-extracted and object-extracted, contain a filler-gap dependency as schematically shown in (5), with the fillers and gaps indicated by italics and underscores, respectively. The IGV would attribute the greater difficulty of processing the object-extracted relative clause to the greater distance between the filler and the gap than exists in the subject-extracted relative clause.

(5) a. Subject-extracted relative clause (SO order)
[*the lawyer*$_i$ that___ $_i$ irritated the banker] filed a hefty lawsuit

b. Object-extracted relative clause (OS order)
[*the lawyer*$_i$ that the banker irritated____$_i$] filed a hefty lawsuit

1.2.2 Universal Cognition View

Another class of claims posits that grammar-independent universal human cognitive factors may play a primary role in determining word order preference. We call this the Universal Cognition View (UCV), which suggests that SO word orders are preferred in all human languages, regardless of the basic word order in individual languages (Bornkessel et al. 2003; Bornkessel-Schlesewsky and Schlesewsky 2009a, 2009b; Kemmerer 2012; MacWhinney 1977; Primus 1999; Tanaka et al. 2011; among others).

Some proposals in this category are concerned with event structure. A prototypical transitive event such as “Naomi cutting a watermelon” involves a transitive action (“cutting”) performed by an agent (the entity that performed the action, “Naomi”) on a patient (the entity that had the action performed on it, “a watermelon”). Primus (1999) argues that the agent–patient order is preferred to the patient–agent order because the patient’s involvement in an event depends on the agent (and his or her actions), rather than vice versa (see also Keenan and Comrie 1977). Bornkessel-Schlesewsky and Schlesewsky (2009a) contend that the first NP in a sentence is preferentially interpreted as the subject because language users prefer simpler intransitive events, which involve only one obligatory participant (animate or inanimate) corresponding to the subject in a sentence, to more complex transitive events, which by definition involve multiple participants corresponding to the subject and the object (see also Gibson 2000 for a related proposal). Other researchers have suggested that the temporal precedence of the agent’s action over the patient’s change of state is captured in an iconic or isomorphic way by the temporal precedence of the subject over the object (Croft 1991, 1998; Langacker 1991, 2008). Putting these and other related proposals together, Kemmerer (2012: 54) goes on to hypothesize that the sequential and hierarchical organization of the prototypical transitive action scenario is extracted by a part of the left IFG, the white area in the schematic of the brain in Figure 1.1.

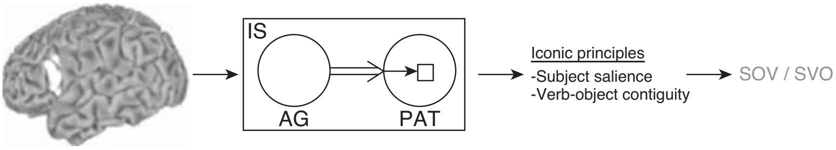

Figure 1.1 A schematic representation of the possible origin of SO word order preference within the Universal Cognition View.
(Adapted from Kemmerer 2012 with permission.)

Another well-known candidate for universal cognitive factors affecting word order preference is the concept referred to variously as empathy, view point, or perspective-taking (Kuno and Kaburaki 1977; MacWhinney 1977). MacWhinney (1977: 152) suggests that speakers tend to choose the perspective most compatible with the perspective they (wish to) assume in their interactions with the world. Both speakers and listeners therefore prefer "the starting point" closest to the one compatible with their perspective. In describing the event of "Naomi cutting a watermelon," for instance, we tend to choose the perspective (closer to that) of the human agent, Naomi, rather than the perspective of the inanimate patient, a watermelon. We therefore prefer the sentence starting with "Naomi" (1a) to the sentence starting with "a watermelon" (1b), resulting in a general SO preference.

Conceptual accessibility is another notion that plays a prominent role in the discussion of constituent order in the psycholinguistic literature, defined as "the ease with which the mental representation of some potential referent can be activated in or retrieved from memory" (Bock and Warren 1985: 50); agents are conceptually more accessible than patients, animate entities are conceptually more accessible than inanimate ones, concrete entities are conceptually more accessible than abstract ones, and so on. Several studies have reported that prominent entities such as agents, animate ones, concrete ones, and prototypical ones tend to appear as sentence-initial subjects (Bock and Warren 1985; Bornkessel-Schlesewsky and Schlesewsky 2009a; Branigan, Pickering, and Tanaka 2008; Hirsh-Pasek and Golinkoff 1996; Primus 1999; Slobin and Bever 1982).

Finally, the UCV may be further supported by the fact that a vast majority of the world's languages feature one of the SO word orders as a basic word order (SOV: 50.1 percent, SVO: 38.3 percent, VSO: 8.2 percent, VOS: 2.0 per cent, OVS: 0.8 percent, OSV: 0.6 percent, Gell-Mann and Ruhlen 2011; see also Dryer 2013).

1.2.3 Relative Contribution of Grammatical Factors and Cognitive Factors

We can summarize the two views reviewed in the previous sections as follows.

(6) Two Possible Sources of Word Order Preference in Sentence Processing

a. Individual Grammar View
Word order preference in sentence processing is largely attributable to grammatical factors of individual languages, such as syntactic complexity.

b. Universal Cognition View
Word order preference in sentence processing is largely attributable to grammar-independent human cognitive features that are universal, such as conceptual accessibility.

Note that grammatical factors and grammar-independent universal cognitive factors are not necessarily mutually exclusive. There is ample evidence that they all affect human sentence comprehension and production in one way or another, as demonstrated in numerous studies, such as those mentioned above. What has not been made clear are their relative contributions and interactions in aspects of sentence processing. Both views correctly account for the SO word order preference in sentence comprehension and production in SO languages (i.e., languages that have one of the SO word orders as a basic word order). In Japanese, for example, SOV is easier to process and more frequently used than OSV, as alluded to above, which may be because SOV is (i) the syntactically simplest word order (IGV) and/or (ii) consistent with conceptual prominence relations (UCV). Thus, it is difficult, if not impossible, to evaluate the relative strengths of these factors by solely focusing on SO languages such as Japanese. To determine which is the primary factor in the observed word order preference and how the factors interact, it is necessary to study languages for which the two views would create different predictions. In fact, in OS languages, the two positions offer opposite predictions regarding preferred order. The IGV predicts OS preference in OS languages because SO word orders have more complex syntactic structures than the syntactically basic OS word order. Thus, unlike in SO languages, OS word orders should require a lower processing cost than SO word orders in OS languages. In contrast, according to the UCV, SO preference should be observed in such languages as well because SO preference does not pertain to the syntactic characteristics of individual languages. Therefore, SO word orders would be processed more easily and used more frequently than OS word orders even in OS languages. For this reason and with these hypotheses in mind, we conducted a series of sentence processing studies on the comprehension and the production of a VOS language, Kaqchikel, a Mayan language spoken in Guatemala. In this book, we report the core results of this project and consider the relationship between language and thought, primarily focusing on constituent order preferences, by drawing on the obtained data.

1.3 Outline of the Book

In Chapter 2, we will sketch aspects of the grammar of Kaqchikel relevant to the discussions in the subsequent chapters. Kaqchikel is a head-marking and morphologically ergative language in which subjects and objects are not overtly case-marked for grammatical relations. Rather, grammatical relations are obligatorily marked on predicates, e.g., a verb with two sets of agreement morphemes, one set for a transitive subject and another for a transitive object and an intransitive subject. The word order of Kaqchikel is relatively flexible, and all of the logically possible six word orders are grammatically allowed. Among these, VOS is considered the basic word order of Kaqchikel by many Mayan language researchers (Ajsivinac Sian et al. 2004: 162; García Matzar and Rodríguez Guaján 1997: 333; Rodríguez Guaján 1994: 200; Tichoc Cumes et al. 2000: 195). For the purpose of the present study, we assume the schematic syntactic structures shown in (7), in which VOS is structurally simpler than the other orders. Because SOV and OSV are rarely used in Kaqchikel, they will not be considered.

(7)

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]]

As we have mentioned above, SO word orders are easier to process than OS word orders in the sentence comprehension of many languages in the world. We will refer to this generalization as the SO Preference in Sentence Comprehension.

(8) SO Preference in Sentence Comprehension
In individual languages with flexible word order, SO word orders are easier to process than OS word orders.

In Chapters 3 to 5, we will consider the sources of this preference and whether the generalization holds true even in an OS language like Kaqchikel. According to the IGV, word order preference in sentence comprehension is largely attributable to grammatical factors of individual languages, such as syntactic complexities. In other words, a language's syntactically determined basic word order should be easier to process than other grammatically possible orders in that language. The IGV therefore predicts that, in Kaqchikel, VOS should be easier to process than SVO, VSO, or OVS. In contrast, according to the UCV, word order preference in sentence comprehension is largely attributable to grammar-independent human cognitive features that are universal, which means that SO word orders should be easier to process than OS word orders even in OS languages. Thus, the UCV predicts that, in Kaqchikel, SVO and VSO should be easier to process than VOS or OVS.

In Chapter 3, we will report two behavioral experiments with a sentence plausibility judgment task in Kaqchikel to test these predictions. In this task, Kaqchikel sentences in one of the three commonly used orders (VOS, SVO, and VSO) were presented in a random order to participants through headsets. The participants were asked to judge whether each sentence was semantically plausible and to push a YES button for correct sentences or a NO button for incorrect sentences as quickly and accurately as possible. The time from the beginning of each stimulus sentence until a button was pressed was measured as the reaction time. We found that semantically natural sentences were processed faster in the VOS order than in the SVO or VSO orders, which suggests that VOS is easier to process than SVO or VSO. These results are compatible with the prediction of the IGV, but not with the prediction of the UCV, showing that the SO preference in sentence comprehension is not fully grounded in the universal properties of human cognition; rather, processing preference may be language-specific to some extent, reflecting syntactic differences in individual languages.

In Chapter 4, we will compare brain activations in response to Kaqchikel sentences with the VOS and SVO orders, obtained using functional magnetic resonance imaging (fMRI). It is known that the left inferior frontal gyrus (IFG) of the brain exhibits enhanced activation in response to grammatically complex, demanding sentences. The fMRI experiment we conducted with Kaqchikel speakers revealed that cortical activation in the left IFG was significantly higher in response to SVO sentences than VOS sentences, which clearly shows that it is the grammatical features of individual languages, and not universal human cognitive features, that primarily modulate brain activation and determine sentence processing load.

In Chapters 5 and 6, we will investigate the time course of the processing of Kaqchikel sentences with alternative word orders. A sentence–picture matching task was employed in two experiments measuring event-related potentials (ERPs). In one of the experiments, a Kaqchikel sentence was presented aurally through a headset; afterwards, a picture was presented in the center of a screen, either matching the event described by the preceding sentence or not. Upon seeing the picture, the participants were asked to judge whether the picture was congruent with the sentence. In the other experiment, a picture was presented before the corresponding sentence. The target sentences used in these experiments were all transitive, with thematically reversible agents and patients, arranged into four word orders: VOS, VSO, SVO, and OVS. A late positive ERP component called P600 was used to examine processing loads, as P600 has been found to be elicited by sentences with a filler-gap dependency, reflecting an increased syntactic processing cost. The results of the two experiments demonstrated that SVO elicited a greater positivity (P600) than VOS, and that VSO elicited a similar posterior positivity, relative to VOS. This range of properties follows naturally from the combination of the IGV and the syntactic structures of Kaqchikel transitive sentences given in (7) above. Most importantly, the results clearly indicate that VOS is the syntactically simplest and easiest-to-process word order of the grammatically possible ones in Kaqchikel, which is in line with our previous findings, described in Chapters 3 and 4. In short, Chapters 3 to 6 present data showing that a VOS preference was observed in Kaqchikel sentence comprehension, which provides empirical support for the IGV.

In Chapter 7, we will turn our attention to basic word order in language and natural order of thought. In his seminal work, Greenberg (1963: 77) observed that, "[i]n declarative sentences with nominal subject and object, the dominant order is almost always one in which the subject precedes the object," a generalization known as Greenberg's Universal 1. Parallel to the SO Preference in Sentence Comprehension, we will refer to this as the SO Preference in Basic Word Order.

(9) SO Preference in Basic Word Order
A vast majority of the world's languages have one of the SO word orders as their basic word order.

This generalization has been firmly supported empirically by a number of subsequent works. Gell-Mann and Ruhlen (2011), for instance, observed the distribution shown in Table 1.1 of the 2,135 languages in their sample.

It is interesting to note that the distribution is heavily biased even among the three SO orders, with SOV being the most frequent, which indicates that SOV has some special status among the six possible word orders in some sense. Why should this be the case? In order to address this question, Goldin-Meadow et al. (2008) showed short animations depicting transitive events (e.g., a girl twisting a knob, a boy opening a box) to speakers of four languages (Chinese, English, Spanish [all SVO], and Turkish [SOV]). The participants were then asked to

Table 1.1 *Order of subject, object, and verb*

SO languages		OS languages	
SOV	50.1%	OSV	0.6%
SVO	38.3%	OVS	0.8%
VSO	8.2%	VOS	2.0%
SO total	**96.6%**	**OS total**	**3.4%**

Note: Calculated based on the number of languages reported in Gell-Mann and Ruhlen (2011).