# Typology and planning scope in sentence production: eye tracking evidence from Tzeltal and Tagalog

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The explanatory potential of language processing for linguistic typology has been advocated by functionalist typologists and psycholinguists alike [1,2,3,4]. Building precise, testable theories of the relationship between real-time language use and typological patterns is, however, hampered by a lack of empirical research on language processing in the vast majority of the world's languages [5]. As a small step towards expanding the typological scope of processing research, we investigate the processes underlying simple sentence production in two verb-initial languages, Tzeltal (Mayan) and Tagalog (Austronesian), using a picture-description/eye tracking task. Our goal was to determine to what extent the time-course of sentence production is affected by differences in basic word order and verbal morphology.

In Tagalog, the verb agrees in semantic role with the "privileged syntactic argument" (PSA), which may be either the agent or patient. In Tzeltal, finite verbs obligatorily cross-reference core verbal arguments by means of person markers which vary depending on the verb's transitivity.

We used a picture description/eye tracking paradigm [6] to investigate sentence planning in the two languages. In this paradigm, participants describe drawings of simple events while their speech and gaze are recorded. It has been demonstrated that eye gaze and speech are tightly correlated in such tasks, and therefore can offer a window into the time-course of sentence planning (for English, cf. [7]). Previous studies suggest that in English, sentence planning may be lexically incremental [8], i.e., speakers may start to speak having encoded only one argument of the to-be-uttered sentence, delaying the encoding of further arguments and the relations among them until after speech onset. This kind of incremental planning is supported by English syntax: verbs are in sentence-medial position and at least for full NPs there are no dependencies overtly marked on the initial subject argument. In verb-initial structures, by contrast, speakers must plan the verb before speech onset. By hypothesis, the morphological information encoded on the verb in verb-initial languages should influence the scope of sentence planning units, because any dependencies morphologically marked on the verb must be planned prior to sentence onset.

53 native Tzeltal speakers and 53 native Tagalog speakers participated in a picture description task in which they had to describe target pictures of simple transitive events that were embedded in a list of intransitive filler pictures; the participants' speech and gaze were recorded (120Hz sampling rate).

In Tagalog a character was more likely to be fixated in an early time window of up to 600ms after stimulus onset if it was selected to be the PSA than if it was the non-PSA. We interpret this as early encoding of the PSA together with the sentence-initial verb. In Tzeltal, by contrast, both characters in the picture were looked at equally often for an extended duration (up to 2000ms after picture presentation). This gaze pattern indicates that both arguments, the subject and the object, are encoded early in the production process together with the verb. We attribute the difference in fixation patterns between Tzeltal and Tagalog to differences in agreement categories marked at the verb. Whereas in Tagalog only the semantic role of the PSA is marked on the verb, Tzeltal verbs mark both the subject and the object, meaning that information about both arguments is required for verb planning. Despite these differences, the fixation patterns of both languages indicate that extensive planning is necessary when preparing to utter verb-initial constructions: unlike English subject-initial sentences, more than just the first-mentioned syntactic element has to be prepared before speech onset.

Our results indicate that grammatical structure influences planning scope during sentence production. Uncovering such structurally driven differences in production processes may ultimately lead to new avenues in the study of the relationship between usage and grammar.

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