Word Order Rules: Parsing Sentences in a “Free” Word Order Language

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Recommended Citation
Batmanian, Natalie and Stromswold, Karin (2020) "Word Order Rules: Parsing Sentences in a “Free” Word Order Language," University of Pennsylvania Working Papers in Linguistics: Vol. 26 : Iss. 1 , Article 5. Available at: https://repository.upenn.edu/pwpl/vol26/iss1/5

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Word Order Rules: Parsing Sentences in a “Free” Word Order Language

Abstract
In fixed word order languages like English, word order is highly predictive of a noun's thematic and grammatical role, and a large body of research has shown that speakers of fixed word order languages tend to rely on word order when they parse and interpret sentences. In flexible word order languages like Turkish, word order is less predictive of nouns’ thematic and grammatical roles, and less is known about the types of cues adult speakers use to determine the meaning of sentences. How do speakers of free word order languages determine the grammatical role of nouns? To answer this question, we presented 28 adult speakers of Turkish 48 stimuli sentences where the word order was varied between SOV and OVS. The cues to aid the grammatical roles were word order, casemarking on the object noun, and when a casemaker was not present an indefinite determiner. The results suggest that, of the three morphosyntactic cues (word order, overt-casemarking, and determiner), word order is the primary cue that Turkish speakers use to assign grammatical and thematic roles, overt object casemarking is a strong secondary cue, and the indefinite determiner is a weaker tertiary cue.
Word order rules: Parsing sentences in a “free” word order language

Natalie Batmanian and Karin Stromswold

1 Introduction

In fixed word order languages like English, word order is highly predictive of a noun’s thematic and grammatical role, and a large body of research has shown that speakers of fixed word order languages often use word order when they parse and interpret sentences (e.g., Townsend & Bever 2001; Ferreira, 2001). In flexible word order languages like Turkish, however, word order is less predictive of a noun’s thematic and grammatical roles, and less is known about the types of cues adult speakers use to determine the meaning of sentences. This paper investigates the cues that native adult Turkish speakers use to interpret sentences with different word orders.

Turkish is traditionally described as a free word order language. All six of the word orders are grammatical when objects are overtly casemarked (Göksel & Kerslake, 2005). However, linguists characterize Turkish as being configurational (Kornfilt, 1994, 1997; Kural, 1992). In (1) through f, sandwich ‘sandviç’ (sandwich) is marked with accusative case ‘–i’ to indicate it is the direct object, and, while the pragmatic force of (1a) is neutral, (1b) conveys that ‘the man ate the sandwich’ and (1c) conveys that ‘the man ate the sandwich’.

(1) a. S O
    Adam sandviç-i yedi.
    ‘The man ate the sandwich.’

b. S V O
    Adam yedi sandviç-i.
    ‘The man ate the sandwich.’

O V S
    Sandviç-i yedi adam.
    ‘The man ate the sandwich.’

c. O S V
    Sandviç-i adam yedi.
    ‘The man ate the sandwich.’

d. V O S
    Yedi sandviç-i adam.
    ‘The man ate the sandwich’

e. V S O
    Yedi adam sandviç-i.
    ‘The man ate the sandwich.’

In Turkish, the nominative case is never overtly marked, whereas whether the accusative case can be overtly marked depends on the word order and pragmatic force of the sentence. Only SOV and OVS word orders are grammatical when the overt accusative casemaker is dropped and, when this occurs, direct objects are indefinite. Non-overtly casemarked objects must be adjacent to the verb to receive structural case (Erguvanlı, 1984; Kornfilt, 1994, 1997, Kural, 1992). When an object is not overtly casemarked, Kornfilt (1997) argues the object receives case by incorporating into the verb and the resulting verb phrase has a different meaning than in an NP-VP construction. Specifically, in the non-casemarked sentences (2) a and b, the incorporation of the noun into the verb results in the sentences conveying the meaning ‘the man engaged in sandwich-eating.’

(2) a. S O V
    Adam sandviç yedi.
    ‘The man ate a sandwich/sandwiches.’

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1 Batmanian has also published under Batman-Ratyosyan
Subject and object NPs are often dropped in spoken Turkish. For example, analyses of child-directed speech revealed that less than 8% of Turkish adults’ sentences contained a subject, an object, and a verb (Batman-Ratyon, 2003). As shown in Figure 1, in sentences that contained all three constituents, 67% were subject-initial, 27% were object-initial and 6% were verb-initial, with SOV being the most frequent word order (Batman-Ratyon, 2003).

Words are revealed one by one in spoken language. In fixed word order languages, research suggests that listeners rely heavily on word order when they assign grammatical and thematic roles to nouns. For example, when English speakers hear a noun-verb-noun sequence, they tend to assume the first noun is the subject and agent of a sentence, and the second noun is its object and patient. Occasionally in English, overt casemarking signals the grammatical role of a noun. For example, in (3a) the noun boy could be the object of the verb believe or the subject of a subsequent verb. This ambiguity disappears when the noun boy is replaced with the third person masculine pronoun which has a different form in accusative (3b) and nominative case (3c). The result is that English speakers are faced with greater processing costs in (3a) than (3b) or (3c) where casemarking disambiguates the second noun’s grammatical role.

(3) a. Mary believed the boy.
  - Mary believed the boy.
  - Mary believed the boy was innocent.
 b. Mary believed him.
 c. Mary believed he was innocent.

In some Turkish sentences, overt casemarking also disambiguates whether a noun is the subject or the object of a sentence. Recall that all six word orders are possible in Turkish when there is an overt accusative casemaker, but only SOV and OVS word orders are grammatical when the accusative casemaker is absent (see Table 1). Thus, in a noun-noun-verb sequence, if a bare noun is followed by a noun, the grammatical roles of these nouns must be subject and object respectively, whereas if a casemarked noun is followed by another noun, the grammatical roles of the nouns must be object and subject, respectively. In the first case, the ambiguity is resolved at the second noun, and, in the second case, the ambiguity is resolved at the first noun. In a noun-verb-noun sequence, the subject-object ambiguity is resolved at the first noun if this noun is casemarked. However, if the first noun is not overtly casemarked, the grammatical roles of the two nouns cannot be determined until the end of the sentence because the first noun could be the subject of an SVO\textsubscript{acc}
WORD ORDER RULES

Thus, the grammatical roles of Turkish nouns become unambiguous at different points depending on whether the object is overtly casemarked or not: these roles are resolved at the first constituent in O_{ACC}VS sentences, at the second constituent in SO_{ACC}V and SO_{O}V sentences, and at the third constituent in O_{O}VS sentences. Given that the underlying word order of Turkish is SOV and subject-initial sentences are considerably more frequent than object-initial sentences in spoken Turkish (Aksu-Koç & Slobin, 1985; Batman-Ratyosyan, 2003), when Turkish speakers parse sentences, it would be reasonable for them to assume that if the first noun of a sentence is not overtly casemarked, it is the subject of the sentence (Batman-Ratyosyan, & Stromswold, 1999). However, if they make this assumption, they will garden-path on O_{O}VS sentences and misinterpret the meaning of O_{O}VS sentences when they fail to reanalyze them.

Table 1. The grammaticality of Turkish word order types as a function of the grammatical role of the first noun and the presence of accusative casemarking.

<table>
<thead>
<tr>
<th>Subject Initial</th>
<th>Object Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Overt Case</td>
<td>+ Overt Case</td>
</tr>
<tr>
<td>NNV  SO_{O}V</td>
<td>S O_{ACC}V</td>
</tr>
<tr>
<td>NVN  *SVO_{O}</td>
<td>SVO_{ACC}</td>
</tr>
<tr>
<td>*O_{O}SV</td>
<td>O_{ACC}S V</td>
</tr>
</tbody>
</table>

Table 2 Method

To investigate how Turkish speakers use word order and casemarking to assign grammatical and thematic roles to nouns in online sentence processing, we had 28 Turkish-speaking adults listen to spoken SOV and OVS sentences in which the object was or was not overtly casemarked. All of the participants were native speakers of Turkish who were tested in Turkey and were attending college in Turkey.

Participants listened to 48 Turkish sentences and indicated the subject/agent of each sentence and rated the acceptability of each sentence on a 1 to 5 scale (with 5 being most acceptable). All sentences were semantically reversible with eight actional Turkish verbs (çek ‘pull’, döv ‘beat’, issr ‘bite’, it ‘push’, kokla ‘sniff’, oksa ‘caress’, öp ‘kiss’ and sev ‘pet’) and three animate nouns (ayı ‘bear’, at ‘horse’ and fil ‘elephant’). Because each noun could plausibly be either the agent or patient of the verb, participants could not use semantics to guide their parsing of stimuli sentences.

There were eight different trial types, with half having the SOV word order and half having the OVS word order. A third of the sentences had objects that were overtly casemarked (SO_{ACC}V, O_{ACC}VS, e.g., 4), a third had objects that were proceeded by an indefinite determiner (SdetO_{O}V, detO_{ACC}VS, e.g., 5), and a third had objects that were neither overtly casemarked nor had the indefinite determiner bir ‘a/one’ (SO_{O}V, O_{O}VS, e.g., 6). Half of the sentences were presented with a context sentence to provide felicity for the topicalized constituents (see example 7).

(4) a. SO_{ACC}V
    At (it-sin.)
    Horse elephant-ACC push-3.SG.OPTATIVE
    ‘Let the horse push the elephant’

   b. O_{ACC}VS
    Fil-i (it-sin) at.
    Elephant- ACC push-3.SG.OPT horse
    ‘Let the horse push the elephant’

(5) a. S detO_{O}V
    At bir fil (it-sin)
    Horse DET elephant push-3.SG.OPT
    ‘Let the horse push an elephant’

   b. detO_{ACC}VS
    Bir fil (it-sin) at.
    DET elephant push-3.SG.OPT horse
    ‘Let the horse push an elephant’
(6) a. **SOₐV**
   At fil it-sin.
   Horse elephant push-3.SG.OPT
   ‘Let the horse push an elephant/elephants’

   b. **OₐVS**
   Fil it-sin at.
   Elephant push-3.SG.OPT horse
   ‘Let the horse push an elephant/elephants’

(7) a. **Context**
   Bu oyun-da at-lar oyna-sın.
   This game-LOC horse-PL play-3.SG.OPT
   ‘Let the horses play in this game.’

   **SOₐV**
   At fil-i it-sin.
   Horse elephant ACC push-3.SG.OPT
   ‘Let the horse push the elephant’

   b. **Context**
   Bu oyun-da fil-ler oynasın.
   This game-LOC elephants-PL play-3.SG.OPT
   ‘Let the elephants play in this game.’

   **OₐVS**
   Fil-i it-sin at.
   Elephant ACC push-3.SG.OPT horse
   ‘Let the horse push the elephant’

3 Analyses

For inferential analysis of the results of this experiment, we used the package *lme4* with the R software (version 3.5.1) to model the binary choice target structure (subject=1 versus object=0) where respondents identified the subject noun (as the agent) in the stimuli sentences. We applied the *glmer* function for Generalised Linear Mixed models specifying the binomial option.

The experiment had a 2x2x2 factorial design with Word Order (SOV versus OVS), Accusative Case (No Overt Case versus Overt Case), and Context (Context versus No Context). A model with Word Order, Case, and Context as fixed effects and Participant, and Verb as random effects failed to converge. Because we were primarily interested in the effect of Case and Word Order, we analyzed Context and No Context sentences separately. These analyses revealed the same interaction between Word Order, and Case, in both Context, and No Context sentences (see Table 2), and for that reason, we eliminated Context from our analyses.

<table>
<thead>
<tr>
<th></th>
<th>NO CONTEXT</th>
<th>CONTEXT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOₐV</strong></td>
<td>No Case</td>
<td>93%</td>
</tr>
<tr>
<td><strong>OₐVS</strong></td>
<td>59%</td>
<td>98%</td>
</tr>
</tbody>
</table>

Table 2. Comprehension Accuracy for No Context and Context trials.

4 Results

Overall, as shown in Figure 2, participants correctly understood 95% of **SOₐV**, 95% of **SOₐV**, and 97% of **OₐVS** sentences. In striking contrast, they understood only 54% of **OₐVS** sentences. A Generalized Mixed Effect model with Word Order and Case as fixed effects and Participant and Verb as random effects revealed a significant interaction between Word Order and Case (see Table 3), due to participants’ poor comprehension of OVS sentences that were not casemarked (see Figure 2). There were no significant effects of either Participant or Verb.
Figure 2. Percent accuracy in the comprehension task as a function of Case (Case and NoCase) and Word Order (SOV and OVS). (Error bars are standard errors.)

Table 3. Fixed effects parameter estimates (in log odds) for the full model without random correlations, and results of the model comparisons. Fixed factors Word Order (SOV and OVS), and Case (NoCase and Case). Number of observations: 1324, participants: 28, verbs: 8.

<table>
<thead>
<tr>
<th>Fixed effects:</th>
<th>Coefficient</th>
<th>SE</th>
<th>z-value</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>3.8026</td>
<td>0.7254</td>
<td>5.242</td>
<td>0.0000000159***</td>
</tr>
<tr>
<td>Word Order (ovs)</td>
<td>2.3548</td>
<td>1.7137</td>
<td>1.374</td>
<td>0.169399</td>
</tr>
<tr>
<td>Case (nocase)</td>
<td>-0.1574</td>
<td>0.9611</td>
<td>-0.164</td>
<td>0.869880</td>
</tr>
<tr>
<td>Case x Word Order</td>
<td>-5.7691</td>
<td>1.7324</td>
<td>-3.330</td>
<td>0.000868***</td>
</tr>
</tbody>
</table>

Analyses of individual participants’ accuracy data for the four sentence types revealed that, of the 28 adults, 21 (75%) did considerably worse on O\_VS sentences than the other 3 types of sentences, and 4 did worse on non-casemarked sentences (SO\_V = O\_VS) than overtly casemarked sentences. Of the remaining 3 participants, one correctly understood all 48 sentences, one made only one mistake (on an SO\_V sentence), and one made 3 mistakes (one each for SO\_V, O\_VS and O\_acc\_VS). In summary, although there was some variability among participants, most found O\_VS sentences more difficult than the other 3 sentence types.

We next analyzed individual participants’ comprehension accuracy for just those sentences that lacked overt accusative casemarking (i.e., O\_VS and SO\_V sentences). These analyses revealed that 25 of the 28 participants were more accurate on SO\_V sentences than O\_VS sentences, and three were equally accurate on the two types of sentences (see Figure 3), a pattern that was highly significant ($p < .000005$ by cumulative binomial sign test). For the SO\_V sentences, 27 participants performed at better than chance level ($p < .05$ by one tail test) and 1 participant performed at chance level. For the O\_VS sentences, 10 participants performed at better than chance level, 12 performed at chance level, and 6 performed at below chance level.

Of the 28 participants, 10 performed at above chance level on both SO\_V and O\_VS sentences, 11 performed at above chance level on SO\_V sentences and at chance level on O\_VS sentences, 1 performed at chance level on both SO\_V and O\_VS sentences, and 6 performed at above chance level on SO\_V sentences and at below level on O\_VS sentences. Note that these last 6 participants basically treated all sentences that lacked overt casemarking as if they were SOV.
The presence of an indefinite determiner had a differential effect on participants’ comprehension of SO_ØV and O_ØVS sentences. As shown in Figure 4, participants correctly interpreted O_ØVS sentences in which the indefinite determiner preceded the object noun (detO_ØVS) more often than O_ØVS sentences that lacked a determiner (71% versus 37%, respectively). In contrast, participants were equally accurate for SO_ØV sentences that did and did not have an indefinite determiner (95% for both).

Of the 28 participants, 24 were more accurate on O_ØVS that had the indefinite determiner than those that lacked determiners, 2 were equally accurate on the two types of O_ØVS sentences, and 2 were more accurate on O_ØVS sentences that lacked determiners ($p < .000005$ by cumulative binomial sign test). As shown in Figure 5, for the O_ØVS sentences that had the indefinite determiner, 13 participants performed at above-chance level ($p < .05$ by one tail test), 13 performed at-chance level, and two performed at below-chance level. For the O_ØVS that lacked determiners, three participants performed at above-chance level, 15 performed at-chance level, and 10 performed at below-chance level.
In addition to the comprehension task, we asked participants to rate the acceptability of the stimuli sentences on a 1 (not at all acceptable) to 5 (most acceptable) scale. As shown in Figure 6, participants rated SO_{acc}V sentences more acceptable (4.21 out of 5) than O_{acc}VS sentences (3.92 out of 5), which were in turn rated more acceptable than SO_{v}V sentences (3.51 out of 5), which were in turn rated more acceptable than O_{v}VS sentences (2.88, all p’s < .001). Thus, the pattern of participants’ acceptability ratings for the 4 sentence types was strikingly different from their comprehension of the 4 sentence types where participants were equally good at comprehending SO_{acc}V, O_{acc}VS, and SO_{v}V sentences (>95% correct) and had very poor comprehension of O_{v}VS sentences (54% correct, see Figure 2).

As shown in Figure 7, for sentences that lacked overt accusative casemarking, participants rated Det SO_{v}V sentences as being the most acceptable (3.7), followed by NoDet SO_{v}V sentences (3.3), which were in turn rated as more acceptable than Det SO_{v}V sentences (3.1), with NoDet SO_{v}V sentences receiving the lowest acceptability ratings (2.6, all ps < .05). Recall that participants had no difficulty understanding SO_{v}V sentences regardless of whether they contained the indefinite determiner (95% correct for both types of sentences), whereas participants had much less difficulty understanding O_{v}VS that contained the indefinite determiner than those that lacked one (71% and 37%, respectively, see Figure 4). Thus, the presence of the indefinite determiner preceding a noncasemarked object affected participants’ acceptability ratings differently than it affected their comprehension: participants rated both SOV and OVS sentences to be more acceptable when they contained an indefinite determiner, whereas presence of an indefinite determiner improved participants’ comprehension of OVS sentences but not SOV sentences.

Figure 5. Scatterplot of individual participants’ comprehension accuracy for non-casemarked OVS sentences with and without a determiner (Det and NoDet).
Figure 6. Acceptability ratings of SOV and OVS sentences with and without accusative case (Case and NoCase). Ratings were on a scale of 1 to 5, with 5 being most acceptable. (Error bars are standard errors.)

Figure 7. Acceptability ratings of non-casemarked SOV and OVS with and without the indefinite determiner (Det and NoDet). Ratings were on a scale of 1 to 5, with 5 being most acceptable. (Error bars are standard errors.)

5 Discussion

The purpose of this study was to investigate what morphosyntactic cues speakers of free word order languages use to parse and interpret spoken sentences. Because the focus of the study was on how morphosyntax affects processing, we used semantically reversible sentences, thereby preventing our participants from using semantic plausibility to interpret sentences. We found that our participants correctly interpreted the SOV sentences regardless of whether the object of the sentences was or was not overtly casemarked or preceded by the indefinite determiner bir ‘a/one’. In striking contrast, the presence of the accusative case or the indefinite determiner had a profound effect on participants’ ability to understand the OVS sentences: When the object of an OVS sentence was overtly casemarked, participants had no difficulty interpreting the sentences, whereas participants correctly understood only half of OVS sentences that lacked overt accusative casemarking. The presence of the indefinite determiner doubled the chances that participants correctly interpreted OVS sentences (from 37% to 71%) but did not fully compensate for the lack of accusative casemarking. These
results suggest that, of the three morphosyntactic cues (word order, overt casemarking, and determiner), word order is the primary cue that Turkish speakers use to assign grammatical and thematic roles, overt object casemarking is a strong secondary cue, and the indefinite determiner is a weaker tertiary cue.

Taken as a whole, our results indicate that, just as speakers of fixed word order languages often use word order heuristics to interpret sentences, speakers of ‘free’ word-order language like Turkish often rely on word order heuristics when they parse and interpret sentences. Although Turkish does allow subjects, verbs and objects to occur in any order, in online processing tasks, it is reasonable for Turkish speakers to assume that the first noun of a Turkish sentence is the subject because, as shown in Figure 1, among three-constituent-long sentences, subject-initial sentences are more than three times as common as object-initial sentences in spoken Turkish (Batman-Ratyosyan, 2003). This “1st Noun = Subject” assumption is even more felicitous when the first noun is not casemarked because 10 times more sentences begin with a subject than begin with a non-casemarked object (see Figure 1).

Our participants’ near-perfect comprehension of SO_{acc}V, SO_{v}V, O_{acc}VS sentences and their poor comprehension of O_{v}VS sentences is consistent with Turkish speakers using a “1st Noun = Subject” heuristic to process sentences. Because both SO_{acc}V and SO_{v}V begin with a subject Turkish speaker who use a “1st Noun = Subject” heuristic should have no difficulty understanding SOV sentences regardless of whether the object has the accusative casemarker or the indefinite determiner. If Turkish speakers initially assume the first noun of an O_{acc}VS sentence is the subject, they will realize that this assumption is incorrect by the end of the first constituent when they process the overt accusative casemaker. Thus, even if Turkish speakers do initially garden-path on O_{acc}VS sentence, they should have no difficult recovering.

What happens if Turkish speakers use a “1st Noun = Subject” heuristic to process O_{v}VS sentences? Given that SVO_{acc} sentences are more than twice as common as O_{v}VS sentences (Batman-Ratyosyan, 2003), they probably would not recognize their error and would continue to garden path until the end of the sentence when they learned that the last noun did not have accusative casemarking (and thus could not be an SVO_{acc} sentence, but must instead be an O_{v}VS sentence). If, by the end of an O_{v}VS sentence, they lack the processing resources required to recognize they have garden-pathed and/or to reparse the sentences, this would explain why our participants misinterpreted half of the O_{v}VS sentences as being subject-initial (Ferreira, Bailey, & Ferraro, 2002). We should caution that, although our comprehension results are consistent with Turkish speakers using a “1st Noun = Subject” heuristic that sometimes leads to fatal gardenpaths, studies that collect more fine-grained, real-time data (e.g., eye gaze studies, ERP studies) are needed to investigate whether this is, indeed, the case.

It is not readily clear why the presence of the indefinite determiner improved our participants’ comprehension of O_{v}VS sentences because in Turkish, the indefinite determiner can precede a subject noun as it does an object noun (e.g., Bir adam bir çocuğun boğul-mak-tan kurtar-dı. A man a child-Drown-Inf.Loc save-Past.3Sg. ‘A man saved a child from drowning.’). Eye gaze studies could clarify whether the presence of the indefinite determiner helps Turkish speakers to avoid garden pathing on O_{v}VS sentences or to recover from the garden-pathing on these sentences.

Recall that our participants were equally accurate at understanding SO_{acc}V, O_{acc} VS, and SO_{v}V (>95% correct for all), yet they gave significantly different acceptability ratings to the three types of sentences (SO_{acc}V > O_{acc}VS > SO_{v}V). There are several possible explanations for this discrepancy. One possibility is that interpreting the meaning of a sentence is an online, automatic process and people are only subject to fatal garden-pathing on O_{v}VS sentences. Rating the acceptability of sentences, on the other hand, is a metalinguistic task, and thus is likely an off-line task in which participants mull over the sentences, perhaps trying to imagine specific situations in which a sentence might be said. If one imagines specific scenarios with specific agents and patients, this would make sentences with overtly casemarked objects (which are definite) better than sentences without overtly casemarked objects (which are indefinite). It would also make SOV sentences better than OVS sentences because SOV sentences are pragmatically neutral whereas OVS sentences are pragmatically marked. Taken together, this would result in SO_{acc}V > O_{acc}VS > SO_{v}V > O_{v}VS acceptability ratings. A second possibility is that, rather than giving acceptability ratings, participants unconsciously rated how difficult they found the sentences to process. If this is the explanation, comprehension reaction times should mirror acceptability ratings more closely than
comprehension accuracy rates do. A final possibility is that the comprehension accuracy-acceptability differences merely reflect the granularity of the measurements in the two tasks: in the comprehension task, participants had only two choices (which of two nouns was the subject), whereas participants rated the acceptability of sentences on a 1 – 5 scale.

Future eye gaze studies, ERP studies, reaction time studies, acoustic studies and analyses of social media may help further clarify how Turkish speakers signal and understand who did what to whom in spoken and written Turkish.

References


