

Garden-path sentences are prosodically marked in Turkish

A crucial step in determining the meaning of a sentence is identifying the grammatical roles of noun phrases and mapping thematic roles onto them. Among the cues that could facilitate this process are propositional content, discourse context, overt case-marking, word order, and prosody. We hypothesize that how people produce and perceive spoken utterances depends on the consistency, reliability and robustness of these cues. Word order is a more robust cue in languages that have a strict word order preference, and case-marking is a more robust cue in languages that have rich overt inflectional morphology. Turkish is an agglutinative language with rich inflectional morphology and flexible word order. Subjects never receive overt nominative case, and objects sometimes receive overt accusative case. If a sentence's object receives an overt accusative marker (O_i), all 6 word orders are grammatical. However, if a sentence's object is not overtly casemarked (O_o), only SOV and OVS word orders are grammatical, with SOV being the pragmatically neutral word order. The result is that, in Turkish, object-initial sentences and sentences lacking overt accusative case-marking are potential garden-path sentences. Most notably, non-casemarked O_oVS sentences are morphologically ambiguous with SVO_i sentences until the end of the very last word. We predicted that when Turkish speakers say sentences in which propositional content, discourse context, casemarking and word order cues for grammatical roles are lacking, they will provide prosodic cues that help their listeners avoid these garden-paths and process the sentences correctly.

Method. Nine native Turkish-speaking adults read aloud 4 sentence types created by orthogonally crossing word order (SOV/OVS) and overt object case-marking (O_i/O_o). Each of the 4 sentence types appeared in 36 scenarios, which were created by pairing two nouns with 36 verbs such that either noun was equally likely to be the agent of the sentence (See Table 1). Sentences were presented in isolation in pseudorandom order. Participants read each sentence silently to themselves until they understood it, and then read it aloud in a clear, natural manner. Participants' sentences were recorded at a sampling rate of 44.1 kHz using a Shure SM10A microphone. Word and morpheme boundaries were marked by hand and mean fundamental frequency (F0) of words and morphemes were determined using Praat (version 6.0.37, Boersma & Weenink, 2018).

Results. The mean F0 contour graphs shown in Figures 1 and 2 were created by binning participants' utterances into 50 msec intervals and determining the F0 for each 50 msec interval. The normalization of F0 for these intervals was done by subtracting each participant's overall mean F0 value from the F0 value of all the intervals uttered by that participant. The F0s for word intervals were analyzed using R's lme4 linear mixed effects package. In the analyses, each word was sliced into equal three intervals, and these intervals, case-marking and word order were predictors, with participant and scenario as random effects. As can be seen in Figure 1, the initial F0 peak was earlier and steeper in sentences with scrambled OVS word order than default SOV word order, and overall, OVS sentences had lower F0s ($t(160.66) = 14.49, p < .001$). Collapsed across word orders, the non-casemarked objects had higher F0s than casemarked objects, and verbs from non-casemarked sentences had lower F0s than those from casemarked sentences in both SOV and OVS word orders (all $ps < .05$). Individual subject analyses revealed that the majority of the participants prosodically differentiated between casemarked and non-casemarked versions of OVS and SOV sentences.

Discussion. Taken as a whole, these results suggest that the structure of Turkish sentences is prosodically indicated when other cues (e.g., word order, overt case markers, discourse context, propositional content) are absent. Consciously or unconsciously, Turkish speakers may be providing prosodic cues to prevent Turkish listeners from garden-pathing. If this is true, Turkish speakers should provide weaker prosodic cues when meaning and discourse context make garden pathing less likely. Turkish listeners should also have less difficulty understanding non-casemarked and scrambled sentences when they are prosodically heavily marked.

	Case-marked object	Non-casemarked object
SOV	Oğlan kız-ı kovaladı. Boy girl-ACC chased.	Oğlan kız kovaladı. Boy girl chased.
OVS	Kız-ı kovaladı oğlan. Girl-ACC chased boy.	Kız kovaladı oğlan. Girl chased boy.

Table 1. An example of four sentence types for the scenario meaning “The boy chased the girl”

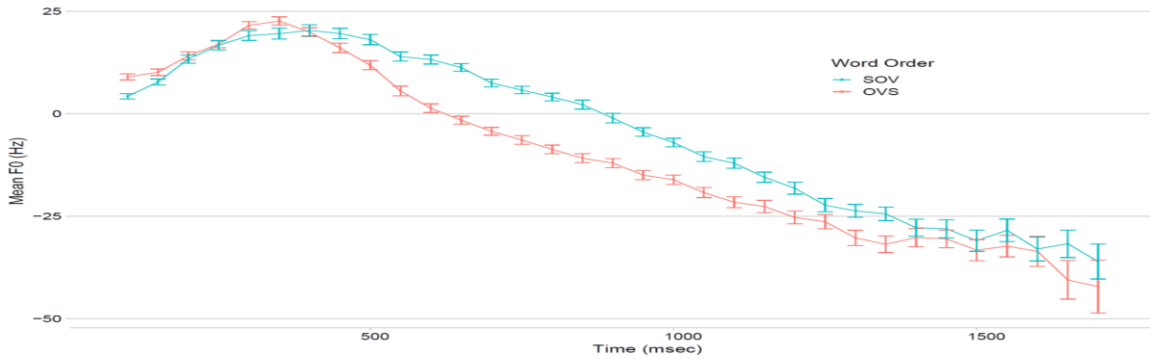


Figure 1. Average F0 for OVS and SOV sentences, collapsed across case-marking, participants, and scenarios. Error bars represent standard errors.

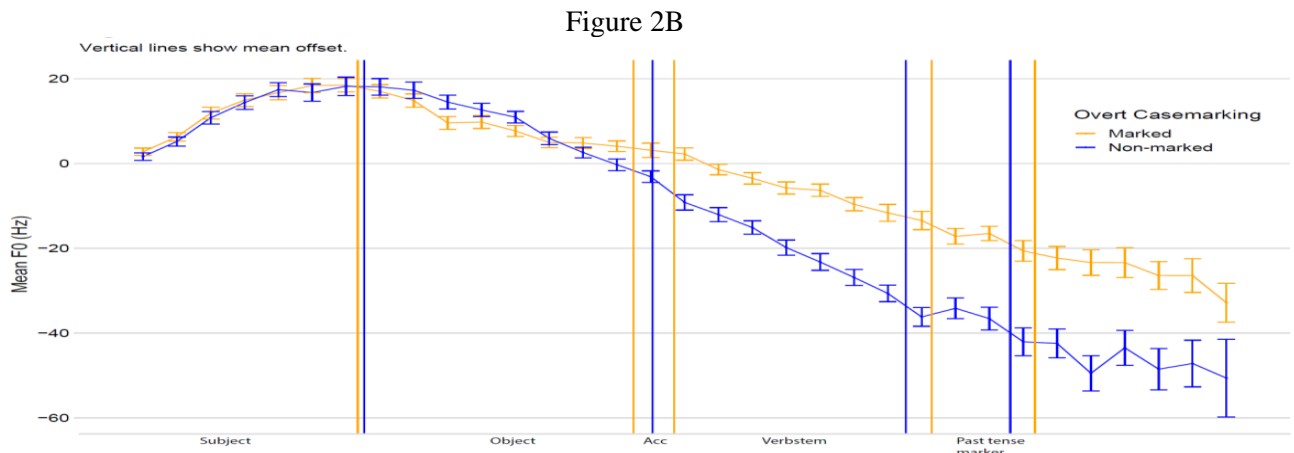
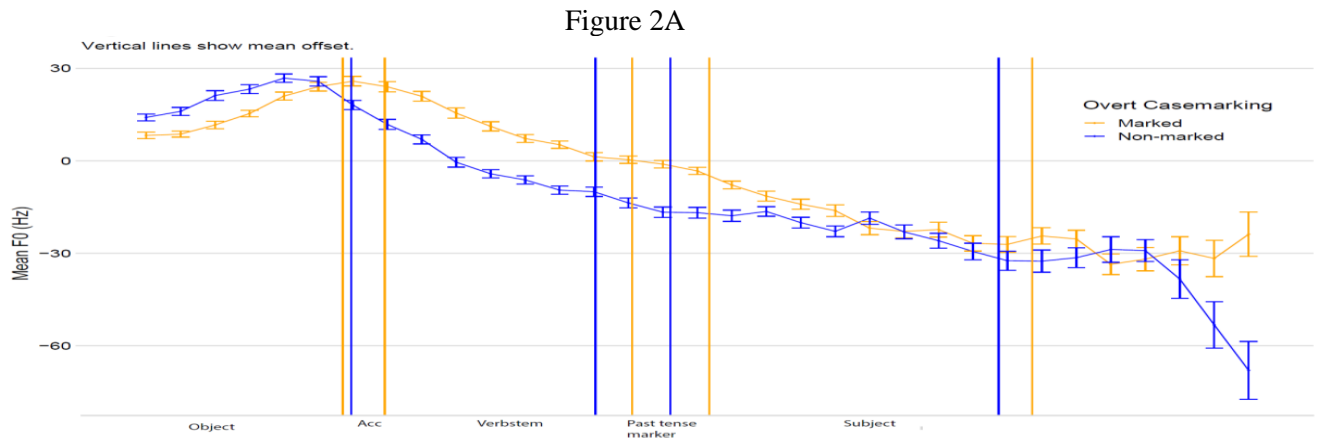


Figure 2. Average F0 for casemarked and non-casemarked OVS sentences (Figure 2A) and SOV sentences (Figure 2B), collapsed across participants. Error bars represent standard errors.