

Speakers and hearers use prosody to disambiguate scopally-ambiguous sentences

Introduction: Sentences such as (1) give rise to multiple interpretations (cf. (2)), based on the scopal relation between the quantifier *all* and negation. An open question in the theoretical literature, dating back to Jackendoff (1972), concerns the role of prosody in disambiguation.

(1) *All the men didn't go*

(2) a. $\nabla > \neg$: none went (claim: falling contour; negation in presupposition: *some men didn't go*)

b. $\neg > \nabla$: not all went (claim: fall-rise; negation focused, not in presupposition: *some men went*)

We present findings from a production study indicating that speakers can manipulate auditory cues to disambiguate these sentences, but that these cues are often not realized as sentence-final contour. We then demonstrate in two complementary perception studies that hearers successfully recruit prosodic information to access the interpretation intended by a speaker and supported by a discourse context. Arguing in support of a pragmatic account, we conclude that speakers and hearers employ the link between prosody and information structure in a discourse context to disambiguate these sentences.

Background: Jackendoff (1972) proposed that each of the interpretations in (2) is paired with a particular prosodic contour, which disambiguates the sentence. Specifically, when negation takes narrow scope, as in (2a), negation is encoded in the presupposition, and the sentence has a falling contour. However, when negation takes wide scope, as in (2b), negation is sentential and part of the focus, not the presupposition, and the sentence has a fall-rise contour (cf. Bolinger, 1965). Jackendoff encoded the distinction directly into the logical representation, consequently predicting that the contour provided by the speaker should invariably disambiguate the sentence. Subsequent researchers (Ladd 1980; Liberman & Sag, 1974; Kadmon & Roberts 1986; Ward & Hirschberg 1985; Koizumi, 2009) questioned the nature of the link between prosody and interpretation, arguing for a central role of pragmatics (e.g., a negative or positive Question Under Discussion, the presence of scalar alternatives). Consequently, while a prosodic correlate to sentence interpretation would still be predicted, prosodic cues – as a consequence of being linked to the context – should be variable.

Thus, it is possible that speakers signal their intended interpretation with prosody, and that hearers can recognize prosody as signaling a particular interpretation. However, while there is some evidence to this effect with similar sentences in Greek (Baltazani, 2002), and for a host of other items in English (e.g., Hirschberg & Avesani, 2000, Price *et al.*, 1991; Speer *et al.*, 1993; a.o.), to date, experimental support for these specific cases in English has remained elusive (cf. Jackson, 2006; McMahan *et al.*, 2003). We argue that because these studies were small scale, focused on the universal quantifier in subject position, and did not systematically manipulate aspects of the discourse context that could give rise to prosodic contrasts, they were therefore not in a position to uncover these trends.

Production Study: 19 undergraduates were recorded reading discourse contexts in which a target sentence such as (1) was embedded and information structure was manipulated, as in (3).

(3) a. Context 1: *most* > negation, negation associated with presupposition

Neil is an avid fan of the theater. I bought tickets to the musical "Chicago" for him as a gift. My friend Adam was concerned about the choice. I realized he was right.

Neil doesn't enjoy most musicals. He thinks they are very cheesy.

b. Context 2: negation > *most*, negation associated with focus/assertion

Neil is an avid fan of the theater. I bought tickets to the musical "Chicago" for him as a gift. My friend Adam was concerned about the choice. I had to assure him that it was ok.

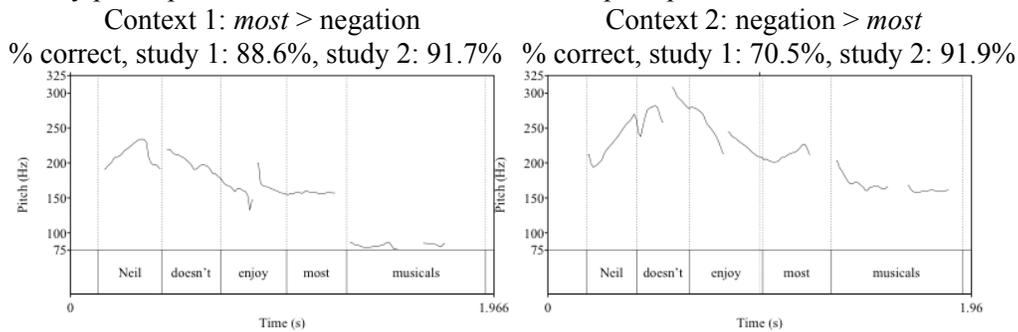
Neil doesn't enjoy most musicals. But I know for a fact that he adores "Chicago."

Target sentences included negation interacting with *all*, *many*, *most*, or *because*; controls involved focus-sensitive operators (*only*, *even*) and pronominal reference. (Total items per speaker: 56) We performed two main analyses on the excised sentences: (1) coding of the sentence-final contour as falling v. non-falling, (2) an acoustic analysis of the lexical item interacting with negation and the sentence-final word. Results indicate that speakers were highly likely to assign a falling contour to the *all* sentences (71-96%), but were more likely to assign a falling contour to *many* > negation sentence than to negation > *many* sentences (91% v. 64%), as predicted. Despite the lack of robust suprasegmental cues, and a range of

variable productions within and across speakers, we did find a significant difference in word duration: the sentence-final word was longest (and the quantifier shortest in *many/most* sentences) when the quantifier took wide scope over negation. Thus, speakers did provide auditory cues to sentence disambiguation.

A subset of the production items were targeted for two perception studies. Items were contributed by an experimenter and three naïve participants who responded to post-context comprehension questions well above chance and produced clear minimal pairs in a manner largely consistent with claims in the theoretical literature. See Figure 1.

Figure 1: A minimal pair for the target sentence *Neil doesn't enjoy most musicals* produced by a naïve production study participant with % correct from each of the perception studies



Perception Study 1: 44 undergraduates were presented with 48 experimental trials each, blocked by speaker, and pseudorandomized within blocks to separate minimal pair members and similar lexical items. Each trial had the same structure: participants saw the target sentence in the middle of the screen, and heard a version of it spoken aloud three times. They were then asked to choose the sentence most likely to follow it, as in (3), thereby placing it in a mini discourse context. Correct responses were those that corresponded to the interpretation intended by the speaker and the discourse context from which the sentence had been taken. Results (see Table 1) indicated that hearers were successful in this task.

Perception Study 2: 37 undergraduates were presented with 36 trials each, in the manner described above. Each trial had the same structure: participants read through a discourse context (self-paced, line by line, cumulative). They then heard two versions of the same target sentence, and were asked to choose the version that best matched the preceding context. Once again, hearers were successful at pairing prosody with interpretation, with the surprising exception of *all > negation* sentences. See Table 1.

Table 1: Average % correct for test item types in two perception studies

| | <i>all, negation</i> | | <i>many/most, negation</i> | | <i>because, negation</i> | |
|--------------|----------------------|---------------------|----------------------------|-------------------|--------------------------|---------------------|
| | <i>all > neg</i> | <i>neg > all</i> | <i>m > neg</i> | <i>neg > m</i> | <i>bec > neg</i> | <i>neg > bec</i> |
| Perception 1 | 69.3** | 66.4* | 62.5** | 76.1** | 62.4* | 76.0** |
| Perception 2 | 76.9** | 53.1 | 88.8** | 84.3** | 79.3** | 85.4** |

All perception results have been analyzed three ways: binomial probability to determine difference from chance level (**: $p < .01$, *: $p < .05$), χ^2 analysis of the distribution of individual responses scores, and ANOVAs comparing the factors *speaker*, *scope of negation*, and *lexical item*.

Conclusions: The results show that prosody does disambiguate these classic quantificational sentences. Further, the variability we observed in the production study, as well as the contribution of contextual factors interacting with prosody and highlighting scopal relations, underscores the central role of information structure. We argue along with Fodor (2002) that psycholinguistic research investigating participants' interpretation of scopally-ambiguous sentences should incorporate prosody into their design.

Selected References: Baltazani (2002). The prosodic structure of quantificational sentences in Greek; Hirschberg & Avesani (2000). Prosodic disambiguation in English and Italian; Jackson (2006). Prosody and logical scope in English; Jackendoff (1972) Semantic interpretation in generative grammar; Koizumi (2009). Processing the *not-because* ambiguity in English: The role of pragmatics and prosody; Ladd (1980). The structure of intonational meaning; Kadmon & Roberts (1986). Prosody and scope: The role of discourse structure; Ward. & Hirschberg (1985). Implicating uncertainty: The pragmatics of fall-rise intonation.