Garden-path no more:Prosody resolves the Complement Clause/Relative Clause ambiguity

Nino Grillo[1], Andrea Santi[2], Miriam Aguilar[3], Leah Roberts[1] & Giuseppina Turco[4]

[1]University of York, [2]Universidad Complutense de Madrid, [3]University College London, [4] Université Paris Cité

nino.grillo@york.ac.uk, a.santi@ucl.ac.uk, miriam.aguilar.lop@gmail.com, leah.roberts@york.ac.uk, gturco@linguist.univ-paris-diderot.fr

Background

Prosodic constituent structure modulates durational properties of words and phrases in a way that reflects their structural and interpretive properties

Duration of segments, words and phrases has also been shown to be strongly affected by their predictability [9, 7, 2, 3, 8, a.o.]

Effects of Prosodic Structure and Predictability are typically assumed to be aligned [14]

Prosodic Structure and Predictability, however, make opposite predictions for nested garden-path sentences [5, 6]

We show that speakers use temporal and tonal cues to prosodically disambiguate classic garden-path sentences involving the Complement Clause and Relative Clause ambiguity **(Experiment 1)**.

We also show that listeners are sensitive to this prosodic disambiguation and can use it to avoid garden-path effects **(Experiment 2)**.

Results in line with Grillo & Turco 2016 and Grillo et al. 2018 [5, 6]: **Prosodic structure leads to shorter duration for less predictable Relative Clauses than more predictable Complement Clauses.**

Experiment 1: Planned Production

Garden-Path sentences like (1) are locally ambiguous between the easier (at least out of context) Complement Clause (CC) analysis (1-a) and the more complex Relative Clause (RC) analysis (1-b) [1, 13].

(1) a. Complement Clause
The kind lyricist told [the editor] [that he was singing with Lola].
b. Relative Clause
The kind lyricist told [the editor [that he was singing with]] [to listen].

Participants Nine English Native speakers (5 women, age range = 24-49, age average=33.1, SD=7.6).

Procedure Planned production, two recording sessions per participant with minimum a one-week gap between sessions.

Materials 24 locally ambiguous CC/RC sentences

Stimuli prosodically controlled (e.g. matched for n. of syllables per region and position of lexical stress at each region across all stimuli)

Analysis

- Annotations of produced utterances performed using Montreal Forced Aligner [10] and manually corrected (blinded to the conditions)
- Duration, rate and F0 movements of 432 productions (24 sentences x 2 conditions x 9 speakers) were automatically extracted using Praat.
- Potential phonological differences of the sentences in the two reading were captured by annotating a subset of the produced sentences (about 10% of the data) in ToBI transcription system

Acoustic Measurements

- **Duration:** Separate temporal measures for the DP matrix object (*the editor*) and the CP including and excluding the last word of the Region of Interest (the Preposition *with*).
- **Tempo:** Duration ratio of the region of interest in relation to the duration of the main clause which more closely reflects the relation between the timing of the region of interest and the preceding phrasal unit and their transition (cf. [12]).
- **F0:** pitch excursion measures of subject DP, object DP, CP and coda. Pitch excursion was calculated by calculating the difference of F0max and F0min in logarithmic scale (see [11]).

Experiment 2: Forced Choice

To determine whether prosodic disambiguation observed in production extends to comprehension, we used the materials from Experiment 1 in a forced-choice auditory comprehension task.

Native English Speakers (N=60) heard sentence fragments up to (but not including) the disambiguating region of ambiguous Complement Clauses / Relative Clauses (e.g. *The kind lyricist told the editor that he was singing with . . .*) and selected between a Complement Clause (*Lola*) and a Relative Clause (*to listen*) continuation.

- 24 Experimental items interspersed with 48 unrelated fillers from production study
- Stimuli produced by a trained linguist were segmented and annotated on the syntactic, word and syllable level using Praat.
- Each minimal pair showed the relevant prosodic differences observed in the production study, including shorter duration of the ambiguous Region of Interest in the RC condition.

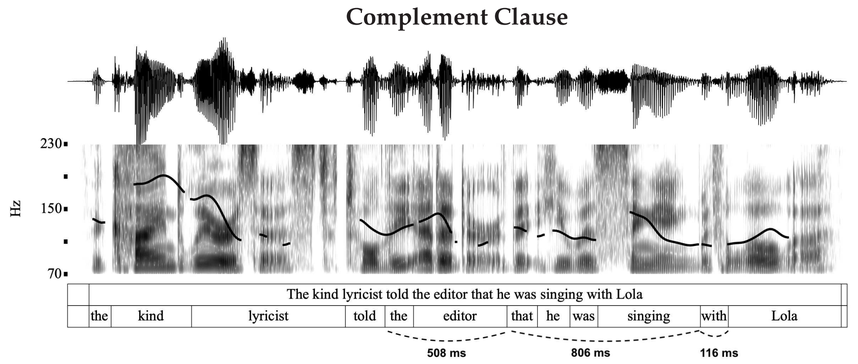
Stimuli

(2) a. Complement Clause Prosody:
The kind lyricist told the editor that he was singing with. . .
b. Relative Clause Prosody:
The kind lyricist told the editor that he was singing with. . .

Relative Clause continuation:
to listen.

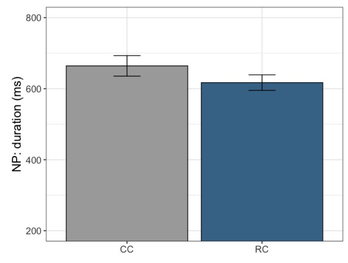
Complement Clause continuation:
Lola

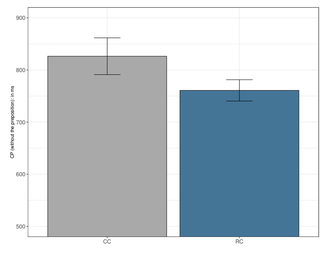
Results Production



Average duration, in ms, of the DP *the editor*, across condition.

Average duration, in ms, of the CP *that he was singing*, excluding the P *with*

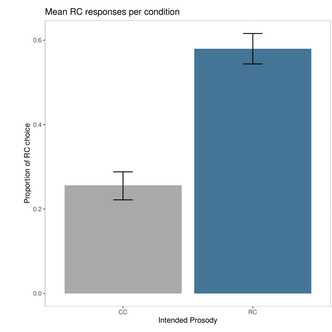




- Significantly longer duration of the DP *the editor* in Complement Clauses (β = -47.12, SE= 17.41; t-value=-2.707; p-value=.0132);
- Significantly longer duration of the CP (excluding the final P *with*) *that he saw singing* in Complement Clauses (β = -65.478, SE=21.734, t-value=-3.013, p-value=.0135).

The distinction in duration between the two conditions is also confirmed when calculating the ratio between the whole duration of the ROI in relation to the duration of the the main clause (ex. *the kind lyricist told*): β =-0.1, SE= 0.03, t-value=-3.3, p-value$<$.01.

Results Comprehension



- Strong effect of Prosody: β = 3.09, SE = 0.4185, z-value = 7.384, p-value = 1.53e-13***
- 8/56 participants never selected a Relative Clause continuation, showing a residual .
- Post-hoc analysis of remaining 48 participants (i.e. those who showed a sensitivity to prosody) show no difference in accuracy across the two conditions.

Discussion

- **Production:** Structural factors determine durational properties above and beyond predictability/complexity
- Shorter duration for more complex Relative Clause (nesting) than easier Complement Clause (sisterhood) analysis (in line with previous results on similar structural contrasts [5, 6])
- **Comprehension:** Prosody strongly reduces (but does not completely cancel) garden-path effect.
- Shorter duration helps disambiguate towards the less predictable/more complex Relative Clause reading.
- **Data demonstrate a clash between prosody-dependent and predictability durational effects**
- **Prosodic structure contribute to durational properties of sentences above and beyond predictability.**
- **Ongoing work seeks to establish relative contribution of duration to disambiguation.**

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