Less predictable and faster: Predictability and duration in *Embedding* and *Sisterhood*

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

[1]University of York, [2]Universidade Nova de Lisboa, [3]University College London, [4]Paris Diderot

Durational properties of speech are largely dependent on complexity, often modelled as a function of predictability. Higher predictability is reliably associated with shorter duration. Prosodic prominence, on the other hand, is associated with lower predictability and thus with longer duration [1-4]. Results from the parsing literature show that a similar relation between duration and predictability is also found in comprehension: the amount of time spent reading a particular region is a function of the strength of prior expectations [5-12]. We present evidence that there exists a set of well-defined structural environments in which *shorter production durations correlate lower predictability* and thus higher complexity. Prosody, it is assumed, does not always disambiguate syntax. The contrast between Main Verb (MV) and reduced-Relative Clause (r-RC) [13], is one classic case of such mapping failure:

A [$_{DP}$ The [$_{NP}$ horse [$_{CP}$ raced past the barn]]] fell. **B** [$_{DP}$ The horse] [$_{VP}$ raced past the barn and fell].

Despite their centrality in shaping theories of sentence processing, no experimental work to date has investigated the prosody of these sentences. Lack of prosodic disambiguation is surprising given that (Higher) Attachment site has been previously shown to correlate with (separate) phrasing [14-17]. This is often observable in terms of durational differences between the two readings, with shorter durations for more deeply embedded strings and longer durations with higher attachment of the same string.

We present evidence from production and comprehension that, contrary to previous assumptions [18,19], this contrast *is* prosodically disambiguated but that this disambiguation is best observed when the relevant clauses are embedded within a matrix clause which provides a baseline pace. Prosodic disambiguation obtains through pace modulation, with *faster* pace associated with the embedded/reduced relative reading and *regular* pace (no change) with main verb analysis. The essential contribution of the matrix sentence is to provide a baseline pace without which it is impossible to establish whether a change took place. *Importantly, duration is solely determined by prosody and independent from complexity/predictability: faster pace is associated with the more complex structure.*

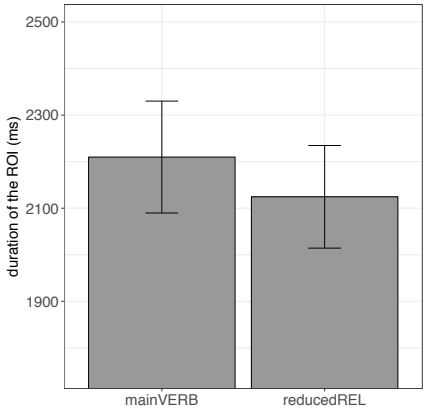
Experiment 1: Planned Production. We compared the prosodic properties of r-RCs (**A**), where the VP is embedded within the DP it modifies, and MVs (**B**), where the VP is in a sisterhood relation with the same DP. *Methods:* Five native English speakers produced 16 experimental utterances per condition (interspersed with 48 unrelated fillers) adapted from previous experiments in the relevant literature [20,21]. Each sentence was embedded within short introductory sentences containing declarative verbs (2,3). Intro strings were neutral with respect to the disambiguation and present solely to provide a baseline tempo. *Predictions*: Prosody predicts *shorter* duration for the r-RC than the MV parse, while the well-known higher complexity of r-RCs leads to the opposite prediction.

2. **Reduced-RC:** Jason claims that *the student pushed into the row of traffic* got badly hurt.
3. **Main Verb:** Jason claims that *the student pushed into the row of traffic* and got badly hurt.

Results. English speakers make use of temporal cues to disambiguate between MV and r-RC readings: the ROI (*the student pushed into the row of traffic*) was significantly *shorter* in the r-RC than in the MV condition (t=-2.729, p=0.0155*). This disambiguation is observable already at the subject DP (*the student*), similarly shorter in r-RCs than MV (t=-2.425, p=0.0167*) (figure 1 and 2). Identical results were obtained with *normalized* duration (ratio of intro sentence -*Jason claims that*- and head NP/ROI).

Experiment 2: 120 English speakers participated in a **forced-choice cloze task** with auditory stimuli produced by one of the participants in Experiment 1, and thus unaware of the goals of the study. Sentences were cut so as to remove the disambiguation regions (i.e. *(and) got badly hurt*), which were presented in text format as forced choice. The crucial manipulation involved presence or absence of intro providing reference tempo (i.e. *Jason claims that* in 2,3). While garden path effects were still present (figure 3), comprehension was significantly better when r-RCs were preceded by the matrix sentence (z= 5.271 p<0.0001), while the opposite effect obtained in the MV condition (z=-2.045, p=0.049). Collectively, data demonstrate a clash between prosody-dependent and complexity-dependent/predictability durational effects, with shorter duration for more complex RC (embedding) than easier Main Verb (sisterhood) analysis. In *Production*, structural factors determine durational

properties above and beyond predictability/complexity. In *Comprehension*, differences in absolute duration (albeit present) are not enough to allow disambiguation: change of pace seems to be essential.



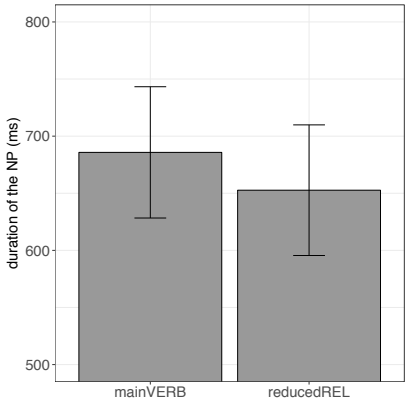


Figure 1 & 2: Average raw duration of the ROI and (head of) the subject DP (in ms) in Main Verb vs. reduced-RC condition

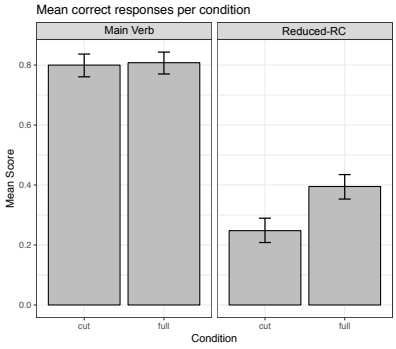


Figure 3: Average proportion of correct responses per condition.

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