ON *DURATION* AND *COMPLEXITY*: THE HORSE RACED FASTER WHEN EMBEDDED

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In current psychological models, and our everyday intuition, a simple correlation exists between relative task complexity and completion duration (when successful). Since Donders' experiments in 1867, (reaction/response) time measures have been correlated with complexity and have consistently provided key insights into processes and mechanisms of the mind. We argue that, while generally sound, in the domain of language, and in particular when prosodic effects on duration are taken into account, this simple correlation can lead to dangerous oversimplifications. (Explicit and Implicit) prosodic properties play a central role in sentence processing [1]. Prosody modulates durational properties of words and phrases to reflect their structural and interpretive properties. We show that these effects can lead to apparently paradoxical cases of shorter durations for more complex structures.

Prosody, it is assumed, does not always disambiguate syntax. The contrast between Main Verb (MV) and reduced-Relative Clause (r-RC), 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. We present evidence from production and comprehension that, contrary to previous assumptions [2,3], 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: faster pace is associated with the more complex structure.* **Experiment 1: Planned Production.** (Higher) Attachment site has been previously shown to correlate with (separate) phrasing [4,5,6,7]. This is often observable in terms of durational differences between the two readings, with shorter durations for more deeply embedded strings and longer durations when the same string attaches to a higher position. 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 [8,9]. 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*). **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, 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).

Ref: [1] Frazier & Gibson 2015 [2] Fodor 2002 [3] Wagner & Watson 2010 [4] Hirschberg & Avesani 1997 [5] Poschmann & Wagner 2015 [6] Wagner 2010 [7] Grillo & Turco 2016 [8] Crain & Steedman 1985 [9] Ni et al. 1996