

Prosody reflects semantic integration in sentence production

Maureen Gillespie^a, Neal J. Pearlmutter^b, Stefanie Shattuck-Hufnagel^c

^aUniversity of Illinois Urbana-Champaign, ^bNortheastern University,

^cMassachusetts Institute of Technology

Semantic relationships among words have been hypothesized to affect the planning processes involved in structuring utterances during fluent production. Watson, Breen, and Gibson (2006) found that syntactically and semantically obligatory arguments were more likely than non-obligatory arguments to be included within the same intonational phrase as their noun or verb heads, and they suggested that prosodic phrasing reflects the simultaneous planning of elements that are linguistically closely related. Semantic integration, the degree of conceptual linkage between elements within an utterance, has been hypothesized to influence the timing of planning of elements within a phrase, such that highly semantically integrated elements are planned with more overlap than less integrated elements (Gillespie & Pearlmutter, 2011; Solomon & Pearlmutter, 2004). But the evidence that integration affects the temporal separation of less integrated elements has been indirect. Because Watson et al. (2006) suggested that planning units in language production are partially dependent upon semantic relationships, and prosody may reflect planning processes, two studies were conducted to examine semantic integration’s effect on prosodic timing.

Study 1 examined the effect of semantic integration on temporal separation of words, within recordings from Solomon & Pearlmutter (2004) of 355 stimuli like (1). Det1 and Det2 were always “the”, Prep was always “with”, and Noun1 was matched between integration conditions. Adj and Noun2 were matched in (combined) number of syllables. Stimulus tokens were read aloud and completed as full sentences. Log-transformed word durations were modeled using linear mixed-effect regression while controlling for other influences on duration (e.g., frequency, speech rate, availability). Lower semantic integration increased the temporal separation between Noun1 and Noun2, as increased duration was observed for Prep, Det2, and Adj. A subset of tokens were also ToBI labeled (Silverman et al., 1992), but prosodic breaks were not reliably placed anywhere between Noun1 and Noun2.

Study 2 examined the effect of semantic integration on prosodic breaks in 509 stimuli like (2) from Gillespie & Pearlmutter (2011), using ToBI labeling. Stimulus tokens were read aloud and completed as full sentences. A logistic mixed-effect model showed an increased likelihood of speakers placing a prosodic break with strength greater than 1 following PP1 in early-integrated (51%) than late-integrated (45%) conditions, suggesting (a) prosodic breaks can be inserted to recover from planning large, semantically-integrated units, or (b) speakers are less likely to prosodically separate semantically integrated material. Additional analyses were conducted on word durations after controlling for a variety of factors, as in Study 1. These results were mixed, but there was suggestive evidence that lower semantic integration resulted in increased separation between Noun1 (the head noun) and the local noun in PP1. This separation was only observed when ToBI labelers reported the presence of a prosodic break between PP1 and PP2.

These studies provide evidence that semantic integration affects prosodic timing during language production, independent of structural differences. This work also strengthens the hypothesis that prosodic timing may, at least in part, reflect underlying planning processes in sentence production (e.g., Watson et al., 2006).

1. The pizza with the yummy topping(s) (integrated)
The pizza with the tasty beverage(s) (unintegrated)
Det1 Noun1 Prep Det2 Adj Noun2
2. [The book] [with the torn page(s)] [by the red pen(s)] (early-integrated)
[The book] [by the red pen(s)] [with the torn page(s)] (late-integrated)
Noun1 PP1 PP2

Gillespie, M. & Pearlmutter, N.J. (2011). Hierarchy and scope of planning in subject-verb agreement production. *Cognition*, 118, 377–397.

Silverman, K., et al. (1992). ToBI: A standard for labeling English prosody. In *ICSLP-1992*, 867–870.

Solomon, E.S. & Pearlmutter, N.J. (2004). Semantic integration and syntactic planning in language production. *Cognitive Psychology*, 49, 1–46.

Watson, D., Breen, M. & Gibson, E. (2006). The role of syntactic obligatoriness in the production of intonational boundaries. *Journal of Experimental Psychology: Language, Memory, and Cognition*, 32, 1045–1056.