Semantic Integration and the Timecourse of Planning Complex Noun Phrases

Neal J. Pearlmutter and Eric S. Solomon, Northeastern University

INTRODUCTION

How is phrase-planning coordinated during sentence production?

Ferreira (1996): *Incremental* rather than *competitive* planning. Speakers began whole sentences sooner with less constrained phrase-ordering options.

—Incremental models are faster given multiple options, because the earliest available option is used.

—Competitive models are slower given multiple options, because the alternatives compete for resources.

Solomon & Pearlmutter (2004): More integrated phrases planned with more component overlap (more *simultaneity*). More integrated phrases yielded higher subject-verb agreement error rates.

—Integration measures strength of relationship between phrase components. E.g., *the pizza with the yummy toppings* is tightly integrated, while *the pizza with the tasty beverages* is less so.

—Simultaneity models predict agreement errors increase with greater integration because features of the relevant nouns (*pizza*, *toppings*) will more often be active together and thus interfere with each other.

Goals

Compare incremental and competitive mechanisms in phrase-internal planning

Examine potential interactions between integration and order constraint

Elicit and manipulate word exchange errors (e.g., *Although <u>murder</u> is a form of <u>suicide</u>...*; Garrett, 1975)

—Often explained by assuming elements are simultaneously active and thus eligible for exchange

—Have not previously been elicited/manipulated systematically in controlled experiments

METHOD

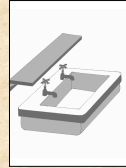36 pictures varying in integration, each paired with 3 linking words (Flexible, Preferred, Unpreferred)

—Integration degree and linking word preferences determined with separate norming

18 Integrated pictures

Flexible
  the spot and the apple
Preferred
  the spot on the apple
Unpreferred
  the apple with the spot

18 Unintegrated pictures

Flexible
  the shelf and the sink
Preferred
  the shelf above the sink
Unpreferred
  the sink below the shelf

3-stage procedure:

—Learning: each picture shown once with nouns (order counterbalanced); self-paced

—Training: each picture shown once, S said nouns aloud, nouns appear after 4 sec as check

—Testing: each picture shown once, with linking word; S described picture using linking word

7 picture-word SOAs (manipulated between-subjects): -750ms, -500, -250, 500, 1000, 1500, 2000

47-54 Ss at each SOA

Dependent measures recorded during testing stage: exchange error rate, speech onset time (from linking word onset for positive SOAs, from picture onset for negative SOAs)

PREDICTIONS

Processing Assumptions

Picture presentation during a test trial:

—creates a syntactic frame (e.g., Dell, 1986) with slots for two nouns (N1, N2),

—sets anticipated times (T1, T2) when slots N1 and N2 will be filled, and

—begins to activate lemmas for N1 and N2 so that their activations peak at times T1 and T2, respectively.

Linking word presentation during a test trial: creates a syntactic frame with slots for two nouns (N1, N2).

Exchange error rate increases as the activation difference between N1 and N2 at T1 decreases.

Speech onset time decreases with ease of filling the N1 slot at T1 (= N1 activation at T1).

If the linking word forces the original N2 to appear first (in the N1 slot), N2's activation level must be increased; the delay increases as N2's activation level at T1 decreases.

Semantic Integration: Simultaneity

Integration alters timing of N1 versus N2 activation; N2 will become active sooner in integrated cases.

Exchange errors: Integrated > unintegrated.

N1-N2 difference is smaller at T1 for integrated cases.

Speech onset time: Integration x Preference interaction.

Relative to corresponding flexible conditions, unpreferred is more difficult for unintegrated than integrated; because at T1, N2 is less active in unintegrated than in integrated.

Integrated

Unintegrated
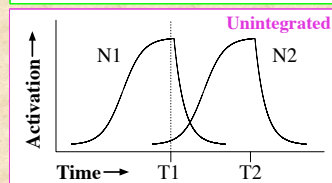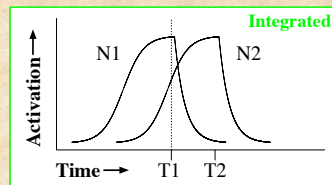
PREDICTIONS (cont'd)

Incremental Planning

Speech onset time: Flexible ≤ Preferred < Unpreferred.

Unpreferred is the only case where N1 and N2 may need to switch.

Competitive Planning

Speech onset time: Flexible ≥ Unpreferred > Preferred.

Flexible is slow because only it involves substantial competition, and unpreferred is slow because it will more often require swapping N1 and N2.

RESULTS & DISCUSSION

Exchange Errors

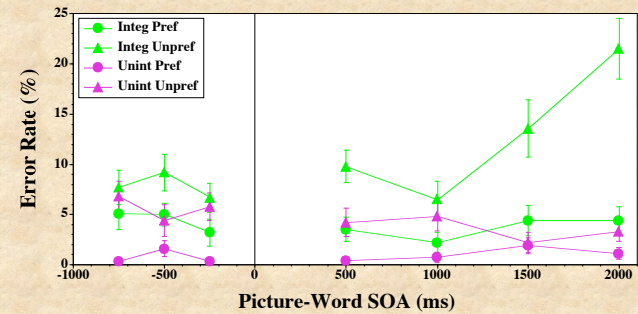Exchange Error Rate = Exchanges / (Exchanges + Correct)

Coded as Correct:
  Exact   *the spot on the apple*
  Close   *the bruise on the apple*

Coded as Exchanges:
  Full   *the apple on the spot*
  Partial   *the apple on, I mean...*

Excluded complete sentences, cases without clear content words, cases with hesitations

Support for simultaneity: More errors for integrated than unintegrated at all SOAs.

Integration x Preference interaction for long SOAs: Suggests T1 is delayed in unpreferred cases. Delay will be shorter for integrated, but then original N1 will still be active, resulting in increased errors.

Speech Onset Time

Includes only Correct trials; trimmed at 4 *SD* within each subject
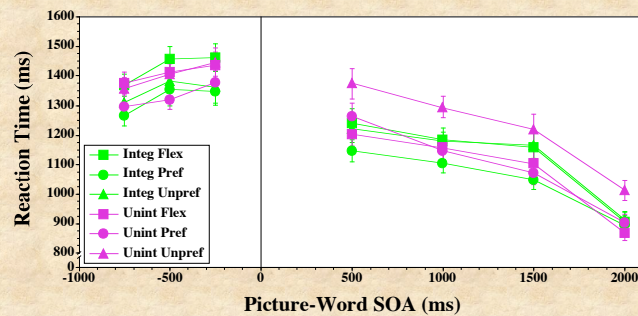
Support for simultaneity: Integration x Preference interaction at positive SOAs;
  for integrated, unpreferred = flexible; for unintegrated, unpreferred > flexible.

Evidence of competitive planning:

—Integrated and unintegrated flexible conditions are slow at negative SOAs.

—Integrated flexible condition is slow at positive SOAs < 2000 ms.

Evidence of incremental planning:

—Unintegrated flexible condition is as fast as preferred at positive SOAs.

—Integrated flexible condition is as fast as preferred and unpreferred at 2000 ms SOA.

Competition seems to arise from lemma competition early in the activation process:

—Negative SOAs reflect competition at any point during lemma activation because lemmas cannot be activated until the picture appears (and speech onset timing starts).

—Positive SOAs reflect competition only if it occurs after the linking word appears. Increased simultaneity in integrated cases permits N2 to compete with N1 for a longer interval of N1's activation.

REFERENCES & ACKNOWLEDGMENTS

Dell, G. S. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review*, **93**, 283-321.
Ferreira, V. S. (1996). Is it better to give than to donate? Syntactic flexibility in language production. *Journal of Memory and Language*, **35**, 724-755.
Garrett, M. F. (1975). The analysis of sentence production. In G. Bower (Ed.), *Psychology of learning and motivation* (Vol. 9, pp. 133-177). New York: Academic Press.
Solomon, E. S., & Pearlmutter, N. J. (2004). Semantic integration and syntactic planning in language production. *Cognitive Psychology*, **49**, 1-46.