Flexibility, Simultaneity, and Exchange Errors in Sentence Production

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INTRODUCTION

How is phrase-planning coordinated during sentence production?

Ferreira (1996) argued for an *incremental* (over a *competitive*) planning model: In whole-sentence production, speakers began speaking sooner when phrase-ordering options were less constrained.

- 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) argued that more integrated phrases are planned with more component overlap (more *simultaneity*) than less integrated phrases: In subject-verb agreement, more integrated phrases yielded higher error rates.

- Integration measures the strength of the relationship between components of a phrase. 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.
- However, *global-activation* models (coupled with plural markedness; Bock & Eberhard, 1993) also predict more agreement errors in more integrated cases, because higher overall activation of features yields more interference with an (unmarked) singular head from a marked plural.

Goals

Compare incremental and competitive mechanisms in phrase-internal planning

Compare simultaneity and global-activation as mechanisms for effect of integration on planning

Examine potential interactions between integration and order constraint

Elicit and manipulate word exchange errors (e.g., *Although murder is a form of suicide...*; 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 degree, 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

47 Ss each completed 3 stages:

- 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, linking word added after 2 sec, S described picture using linking word

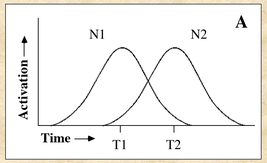
Speech onset time (from linking word appearance) and speech content recorded during testing stage

PREDICTIONS

Assumptions

Picture presentation during a test trial:

- creates a syntactic frame (e.g., Dell, 1986) with slots for two nouns (N1 and N2),
- sets anticipated times (T1 and T2) when slots N1 and N2 will be filled, and
- begins to activate lemmas for N1 and N2 so that their activations will peak at times T1 and T2, respectively.



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

Speech onset time depends on ease of filling the N1 slot at T1, decreasing as N1 activation at T1 increases.

If the linking word forces what was planned as N2 to appear first (in the N1 slot), the system must increase N2's activation level; the delay increases as N2's activation level at T1 decreases.

Incremental Global-Activation Model

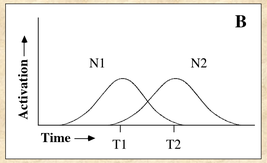
A = Integrated conditions B = Unintegrated conditions

Exchange errors:

- Unintegrated > Integrated: N1-N2 difference at T1 is smaller for unintegrated cases.

Onset time:

- Integrated < Unintegrated: N1 is higher in A than B.
- Flexible ≤ Preferred < Unpreferred: Unpreferred is only case where N1 and N2 may need to switch



Incremental Simultaneity Model

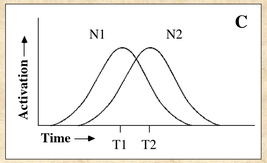
C = Integrated conditions A = Unintegrated conditions

Exchange errors:

- Integrated > Unintegrated: N1-N2 difference at T1 is smaller for integrated cases.

Onset time:

- Flexible ≤ Preferred < Unpreferred: Unpreferred is only case where N1 and N2 are likely to switch
- Interaction: Relative to corresponding flexible conditions, unpreferred is more difficult for unintegrated than integrated; at T1, N2 is lower in unintegrated than in integrated.



Competitive Models

Competitive global-activation and simultaneity models generally predict the same effects as corresponding incremental models with respect to integration effects.

They differ primarily on onset time flexibility effects, predicting Flexible > Unpreferred > Preferred.

- Flexible is slowest because only it involves substantial competition.
- Unpreferred is slower than preferred because the former will more often require swapping N1 and N2.

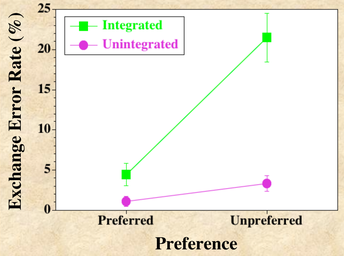
RESULTS

Exchange Errors

Coded as Correct:		Coded as Exchanges:	
Exact	*the spot on the apple*	Full	*the apple on the spot*
Close	*the bruise on the apple*	Partial	*the apple on, I mean...*

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

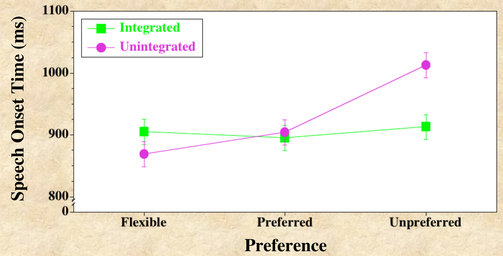
Exchange Error Rate = Exchanges / (Exchanges + Correct)



- More errors for integrated than unintegrated
- Integration effect within both preferred pair and unpreferred pair
- More errors for unpreferred than preferred
- Preference x Integration interaction

Speech Onset Time

Included only correct trials; trimmed at 4 *SD* within each subject



Preference x Integration interaction:

- Neither flexible pair nor preferred pair differ, but unpreferred pair do.
- Integrated conditions do not differ.
- For unintegrated conditions, Flexible ≤ Preferred < Unpreferred (also appears as a main effect).

DISCUSSION

Strong evidence for incremental simultaneity model:

- More exchanges in integrated than in unintegrated cases, in both preferred and unpreferred conditions
  - Intended N2 noun is more likely to be accessible and incorrectly inserted in N1 slot in integrated cases
  - Result of increased overlap in timing of activation
- Interaction in speech onset time: Difference between integrated unpreferred and integrated flexible was smaller than corresponding difference for unintegrated conditions
  - In integrated cases, switching N2 to the N1 slot in unpreferred is relatively easy, because it is already active at T1.
  - In unintegrated cases, switching N2 at T1 is relatively difficult, because it is not particularly active.
  - No integration differences in preferred or flexible conditions because little (or no) switching to N2 is needed, and N1 is equally active in integrated and unintegrated cases.

Global-activation models predict reversed effect of integration in exchange errors.

Competition models predict reversed effect of preference.

One unexpected result: Very high exchange error rate in integrated unpreferred condition.

- All models compatible with preference main effect in errors, and simultaneity models predict Integrated > Unintegrated, but no models predicted the interaction.
- A possible explanation comes from assuming that the effect of the unpreferred linking word is to delay T1 until the appropriate noun can be prepared (the current N2 noun), which will predict an interaction:
  - The delay will be shorter in the integrated case, because N2 will already be relatively active (correctly predicting little increase in onset time for correct integrated unpreferred trials).
  - But the original N1 will also likely be more active when the new T1 arrives, increasing error rates relative to unintegrated cases.
  - In unintegrated cases, the longer delay needed to activate N2 will also permit the original N1 to decay.

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