Interference Effects in Sentence Comprehension: A Synthesis

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Interference in Dependency Resolution

- Interference in syntactic dependency resolution is considered key evidence for cue-based retrieval in language processing.
- The presence or absence of interference has been interpreted in favor or against parsing models reyling on cue-based retrieval such as the LV05 ACT-R model (Lewis & Vasishth, 2005).
- The results are inconsistent across studies.

→ We synthesize the evidence by presenting a Bayesian random-effects meta-analysis.

a. **Target-match; distractor-mismatch**

The musicians$^{-sing}_{-local\ subject}$ who the reviewer$^{+sing}_{+local\ subject}$ praises$\{^{sing}_{local\ subject}\}\ldots$

b. **Target-match; distractor-match**

The musician$^{+sing}_{-local\ subject}$ who the reviewer$^{+sing}_{+local\ subject}$ praises$\{^{sing}_{local\ subject}\}\ldots$

c. **Target-mismatch; distractor-mismatch**

The musicians$^{-sing}_{-local\ subject}$ who the reviewers$^{-sing}_{+local\ subject}$ praises$\{^{sing}_{local\ subject}\}\ldots$

d. **Target-mismatch; distractor-match**

The musician$^{+sing}_{-local\ subject}$ who the reviewers$^{-sing}_{+local\ subject}$ praises$\{^{sing}_{local\ subject}\}\ldots$

source: Wagers et al. 2009

Bayesian Meta-Regression: Model Specification

$$
\begin{aligned}
y_i \mid \theta_i, \beta, \sigma_i^2 &\sim N(\theta_i + \beta_{pro/retro} \times pro/retroactive_i, \sigma_i^2) \quad i = 1, \ldots, n \\
\theta_i \mid \theta, \tau^2 &\sim N(\theta, \tau^2), \\
\theta &\sim N(0, 100^2), \\
\beta_{pro/retro} &\sim N(0, 100^2), \\
\tau &\sim N(0, 100^2)T(0,)\text{(truncated normal)}
\end{aligned}
$$

y_i: observed effect (ms) in experiment $i = 1, \ldots, n$

θ: true (unknown) effect to be estimated by the model adjusted for the effect of pro- vs. retroactive interference $\beta_{pro/retro}$

σ_i^2: true variance of the sampling distribution; each σ_i is estimated from the standard error available from experiment i

τ^2: variance parameter representing between-experiment variance

θ_i: true interference effect in experiment i adjusted for the effect of pro- vs. retroactive interference $\beta_{pro/retro}$

$pro/retroactive$: pro- vs. retroactive interference as regression predictor with sum contrast coding (proactive coded as $+1$)

$\beta_{pro/retro}$: coefficient of the pro/retroactive interference regression predictor

Inclusion Criteria

- Experiments using a target-/distractor-match/mismatch design
- Dependency types:
  - Subject-verb number agreement (n=15)
  - Other subject-verb dependencies (n=17)
  - Reflexive-/reciprocal-antecedent dependencies (n=19)
- Self-paced reading (reading times) or eyetracking (gaze duration)
- Healthy, adult native speakers of the examined language

Results

Dependency	Effect	Target	Estimate	95% Credible Interval	P(Estimate>0)	LV05	
Subject-verb (non-agreement)	Interference	Match	13	$[1.6, 28.1]$	0.98	*inhibition*	✓
	Pro/retroactive	Match	-5.1	$[-19.2, 6.9]$	0.19	*retro>pro*	✓
Subject-verb agreement	Interference	Match	0.6	$[-9.9, 12.3]$	0.53	*inhibition*	✗
		Mismatch	-15.8	$[-33.2, 1.8]$	0.04	*facilitation*	✓
	Pro/retroactive	Match	12	$[1.6, 23.6]$	0.99	*retro>pro*	✗
		Mismatch	1.8	$[-15.6, 19.6]$	0.58	*pro>retro*	✗
Reflexives/ Reciprocals	Interference	Match	2.4	$[-3.2, 7.9]$	0.81	*inhibition*	✓
		Mismatch	11.6	$[-5.7, 29.1]$	0.91	*facilitation*	✗
	Pro/retroactive	Match	4.1	$[-1.3, 9.6]$	0.93	*retro>pro*	✗
		Mismatch	-0.9	$[-18.3, 16.6]$	0.46	*pro>retro*	✗

Discussion

The evidence from reading studies published so far suggests that

i) the existing evidence is only partially consistent with the Lewis & Vasishth ACT-R model of cue-based retrieval.

ii) interference manipulations have different effects depending on the dependency type.

iii) interference type (proactive versus retroactive) affects different dependency types in different ways.

References

Badecker & Straub (2002); Chen, Jäger, Vasishth (2012); Cunnings & Felser (2013); Cunnings & Sturt (2014); Dillon, Mishler, Sloggett, Phillips (2013); Felser, Sato, Bertenshaw (2009); Franck, Colonna, Rizzi (2015); Jäger, Engelmann, Vasishth (2015); Lago, Shalom, Sigman, Lau, Phillips (2015); Patil, Vasishth, Lewis (2016); Pearlmutter, Garnsey, Bock (1999); Sturt (2003); Tucker, Idrissi, Almeida (2015); Van Dyke (2007); Van Dyke & Lewis (2003); Van Dyke & McElree (2006); Van Dyke & McElree (2011); Wagers, Lau, Phillips (2009)