

Three Myths about Re-Mention Biases

The current scientific consensus is that comprehenders rapidly form expectations about how the discourse is likely to continue – expectations driven primarily by an interaction of discourse relations/structure and world knowledge (e.g., see DETECT2013 Call for Submissions). *At least with regards to re-mention biases* (a widely-studied discourse expectation phenomenon, defined below), while a central role for discourse relations is well supported, the other parts of this claim (rapid calculation, role for world knowledge) are not, with important consequences for theory.

Re-mention biases. Sentences and clauses relate to one another in structured ways. While the exact enumeration and definition of these “discourse relations” remains in dispute [1-2], two commonly-cited relations are EXPLANATION, in which the second clause explains the situation described by the first (*Sally made Mary angry because she broke Mary's things*), and RESULT, in which the second clause describes a result of the situation described by the first (*Because Sally made Mary angry, she isn't friends with Sally anymore*). The differential expectations driven by discourse relations can be measured in pronoun resolution tasks; in the absence of additional information, most comprehenders interpret the pronoun in (1a) as referring to Sally and the pronoun in (1b) as referring to Mary [2-11]:¹

- (1) a. Sally angered/frightened/delighted Mary because she...
b. Because Sally angered/frightened/delighted Mary, she...

Identical results can be obtained by truncating these sentences prior to the pronoun (*Sally angered Mary because...*) and asking people to propose continuations: most continuations of (1a) refer to Sally, and most continuations of (1b) refer to Mary. In general, sentence continuation and pronoun interpretation tasks give nearly identical results, with correlation coefficients frequently topping 0.9 [2,4,5].

Meaning also plays a role, with the typical pronoun resolutions in (2a) and (2b) being the opposite of (1a) and (1b), respectively:

- (2) a. Sally loved/feared/hated Mary because she...
b. Because Sally loved/feared/hated Mary, she...

This interaction is complex, as other verbs lead to object interpretations of the pronoun regardless (*Sally criticized Mary because she...; Because Sally criticized Mary, she...*).

Myth #1. Discourse expectations develop rapidly. Studies of pronoun resolution in explanatory contexts (e.g., 1a, 2a) using a variety of online measures have all concluded that discourse expectations affect pronoun resolution soon after pronoun onset [8-11]. However, when analyzed separately, these rapid effects are often much less robust for object-biased sentences than subject-biased sentences (e.g., Table 1, top).² This sluggish response in object-biased sentences has been explained as an artifact of a global subject-bias [9-10], which applies in all discourse contexts, affecting online processing though apparently not always off-line judgments. If so, passivizing the sentences (*Sally was loved by Mary because she...*) should reverse the effect. It does not (Table 1, bottom). A subsequent experiment involving RESULT contexts failed to show any evidence of rapid resolution. Thus, rapid discourse expectations are far from ubiquitous.

Myth #2. Minimal role for linguistic semantics. Re-mention biases are governed both by discourse relations and by meaning. Many researchers have argued that the relevant aspects of the event (e.g., that *Sally* caused the event *Sally angered Mary*) are not linguistically specified have to be inferred from world knowledge. This line of reasoning would not hold if it could be shown that the verbs do in fact encode this information.

Linguistic research has suggested that the syntactic behavior of verbs (such as the syntactic frames it can appear in) is partially if not mostly a function of semantic features [12]. Interestingly, when verbs are classified according to syntactic behavior, these same classes predict re-mention biases, both for explanatory sentences (e.g., 1a & 2a) [4-5] and for result sentences (e.g., 1b & 2b)

¹ Sentences like (1a) and (1b) are frequently called “implicit causality” and “implicit consequentiality” sentences, respectively.

² Participants (N=28 per condition) read sentences with active or passive verbs. Verbs were either emotion verbs that encode the experiencer of the emotion as the object (“experiencer-object verbs”: frighten, delight) or emotion verbs encoding the experiencer as the subject (“experiencer-subject verbs”: fear, love). The former are reliably NP1-biased in active sentences and NP2-biased in passives; *vice versa* for the latter.

(Figure 3). This suggests that comprehenders need not infer the relevant aspects of the event (e.g., causality); they come for free as part of comprehending the verb. In fact, the features of the event necessary to explain a verb's re-mention biases are frequently exactly those *semantic* features invoked by linguists to explain syntactic behavior of the verb (e.g., *frighten* specifies its subject as the cause).

Myth #3. World knowledge about event-participants affects re-mention biases. While world knowledge may not play a role in verb-derived re-mention biases, researchers have suggested that world knowledge about the event participants (e.g., Sally, Mary) does [e.g., 13]. However, after an exhaustive literature review and eight new experiments, Hartshorne was only able to (partly) confirm one such claim: gender can slightly modulate verb-bias when the event participants are of mixed gender (Sally frightened John because...) such that being male makes an event participant slightly more likely to be mentioned [4; see also 14]. However, this was true for only about 5% of the 300+ verbs investigated. While robust effects of world knowledge on re-mention biases may yet be discovered, for now, data at hand support no more than a peripheral role for world knowledge.

Conclusion. Some discourse expectations can be rapidly formulated, but others cannot be. World knowledge plays a role in some discourse expectations [e.g., 15], but not all. Understanding the constraints on discourse expectations will provide an exciting challenge for researchers over the next decade or more. Discourse expectation research has become progressively more interesting.

Table 1

	50	150	250	350	450	550	650	750	850	950	1050
<u>Active Verbs</u>											
Exp-Obj	49%	49%	45%	53%	57%	62%*	68%**	68%**	68%**	64%**	66%**
Exp-Subj	46%	46%	48%	46%	47%	51%	51%	51%	49%	47%	48%
<u>Passive Verbs</u>											
Exp-Obj	49%	52%	53%	55%	57%	62%*	68%**	68%**	68%**	64%**	66%**
Exp-Subj	57%	61%	62%	63%*	59%	54%	52%	52%	52%	56%	56%

Percentage looks to **target** in 100ms blocks from pronoun onset. See Footnote 2 for design.

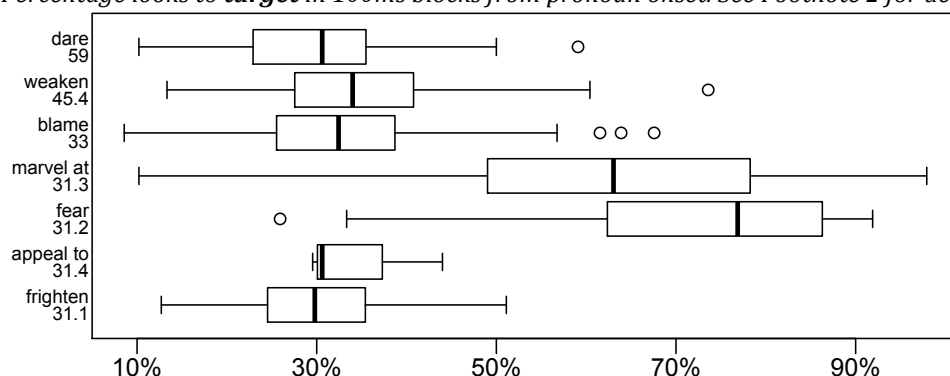


Figure 1. Box-and-whisker plots by verb for subject-bias in RESULT sentences (e.g., 1b, 2b) for all monosemic verbs in seven syntactic verb classes. Nearly all verbs in classes 31.2 & 31.3 are more object-biased than nearly all verbs in the other five classes. Methods are similar to [6].

1. Wolf & Gibson (2006). *Coherence in Natural Language: Data Structures and Applications*
2. Kehler, Kertz, Rohde & Elman (2008). *Journal of Semantics*.
3. Garvey & Caramazza (1974). *Linguistic Inquiry*.
4. Hartshorne (accepted pending minor revisions). *Language & Cognitive Processes*.
5. Hartshorne, Sudo & Uruwashii (in press). *Experimental Psychology*.
6. Hartshorne & Snedeker (in press). *Language & Cognitive Processes*.
7. Stewart, Pickering & Sanford. (1998). *CogSci Proceedings*.
8. Cozjin, Commandeur, Vonk & Noordman (2011). *Journal of Memory & Language*.
9. Koornneef & van Berkum (2006). *Journal of Memory & Language*.
10. Pyykkonen & Jarvikivi (2010). *Experimental Psychology*.
11. Featherstone & Sturt (2010). *Quarterly Journal of Experimental Psychology*.
12. Levin & Rappaport-Hovav (2005). *Argument Realization*.
13. Pickering & Majid (2007). *Language & Cognitive Processes*.
14. Ferstl, Garnham & Manouilidou (2011). *Behavior Research Methods*.
15. Otten & van Berkum (2008). *Discourse Processes*.