Semantic Decomposition of Verbs and the Processing and Production of Result States

Keywords: Psycholinguistics; Lexical semantics; English

Background In this study, we investigate how (a) verb semantics and (b) discourse context guide people's processing (Exp.1) and production (Exp.2) of result states. We focus on two types of verbs that involve different event structures: manner verbs (e.g. *hit, strike*) and result verbs (e.g. *break, shatter*). Result verbs lexically specify the change-of-state involved (e.g. *broken*), as in (1) (e.g. [5], [6]). Manner verbs, on the other hand, do not have a change-of-state subevent, as in (2) (e.g. [5], [6]).

(1) **Result verb** *break*: [*x* ACT_{<MANNER>} CAUSE [BECOME [*y* <*BROKEN*>]]]
(2) **Manner verb** *hit*: [*x* ACT_{<HIT>} *y*]

Although manner verbs do not lexicalize result states, they can be used to infer result states (e.g. [6], [7]):

(3) Mary struck the vase → The vase is broken.

This semantic difference between result verbs and manner verbs allows us to compare the processing and production of result states that are (a) already lexicalized in the preceding verb or (b) pragmatically inferred.

Research Questions (i) How does verb semantics (presence/absence of a change-of-state subevent) affect the processing (Exp.1) and production (Exp.2) of result states? **(ii)** How does discourse context guide the processing (Exp.1) and production (Exp.2) of result states, especially when the result state is not lexically specified in the preceding verb? We test both comprehension and production to assess how the language processing system integrates input and produces output; two related but non-identical aspects of processing.

Comprehension: Exp. 1 (40 native English speakers, self-paced reading) manipulated (i) context type (result-supporting vs. *neutral*) and (ii) verb type (mannerV vs. *resultV*) for a 2×2 design (Table 1).

Table 1: Sample target item for Exp. 1 (34 targets, 48 fillers)

Trevor called and asked Mary **what happened to**$_{\text{result\_supporting\_Context}}$/***about***$_{\textit{neutralContext}}$ the merick.
She replied that she **hit**$_{\text{mannerV}}$/***broke***$_{\textit{resultV}}$ it in the morning on Monday.
She said that it is **damaged**$_{\text{result-phrase}}$ and that she feels very sorry about this.

The result-supporting context focuses on the result state of the object (e.g. the 'fate' of the merick), in contrast to the neutral context. Nonce nouns were used to avoid noun semantics influencing the plausibility of result attainment. All targets contain a result phrase (e.g. *damaged*). How do verb type and context type influence how quickly the result phrase is read?

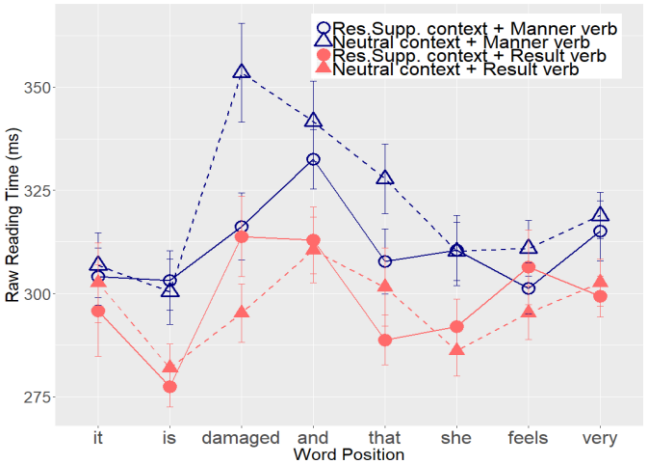

Figure 1: Reading Times at the Result Phrase Region

Results (Fig.1): The **result phrase** (e.g. *damaged*) is read faster after resultV than after mannerV (*lmer*, |t|=2.71). There is also a significant interaction (|t|=2.05): in result-supporting contexts, result phrases in the manner verb condition are read as fast as in the result verb condition (|t|=0.19). In neutral contexts, however, reading times for result phrases in the mannerV condition are longer than in the resultV condition (|t|=3.14).

Discussion: Lexical semantics and discourse context both influence the processing of the upcoming result phrase. (i) When the preceding resultV lexicalizes the result state, the result phrase is read faster than when the result state is not specified in the semantics of the preceding mannerV. (ii) When discourse context supports the existence of a change-of-state, it facilitates the processing of a result phrase even if it is not entailed by the preceding mannerV.

Production: Exp. 2 (40 new participants) investigates how lexical semantics and discourse context influence *how likely people are to mention result states in upcoming discourse*. We were especially interested in whether people would be less or more likely to mention a result state when it is already lexicalized in the preceding verb. We adapted the stimuli from Exp.1, truncating them before the result phrase (Table 2). Participants wrote completions for these clause fragments.

The continuations were analyzed for (i) whether or not they describe a result and (ii) if so, what kind (examples in Table 3): *Direct result* describes an immediate result state that follows directly from the action

(e.g. jabbing the crail causes holes). This is the type of result lexicalized in resultVs. *Indirect result* describes an indirect consequence/event that follows the result state (e.g. jabbing the crail damages it which creates a need for replacement).

Table 2: Sample target item for Exp. 2 (24 targets, 24 fillers)

Trevor called and asked Mary { what happened to / *about* } the merick.
She replied that she { hit / *broke* } it in the morning on Monday.
She said that it is …

Table 3: Examples of continuations from Exp. 2

Jim called and asked Jessica [what happened to/about] the crail. She answered that she jabbed it at noon on Wednesday. She also said that it is …	
Direct result	*full of holes now.*
Indirect result/consequence	*going to be replaced later this afternoon.*
Non-result	*a bit rusty and probably was about to cave in anyway.*

Results: People produce more result-related continuations (all result types combined) after resultV than mannerV ($|t|=3.93$), regardless of context (no context effect, no interaction, Fig.2). However, looking at the subtypes of result-related continuations (Fig.3) shows that the proportion of *direct results* is higher after mannerV than resultV. Conversely, the proportion of *indirect results* is higher after resultV than after mannerV ($|t|=2.03$). There is no effect of context and no interaction.

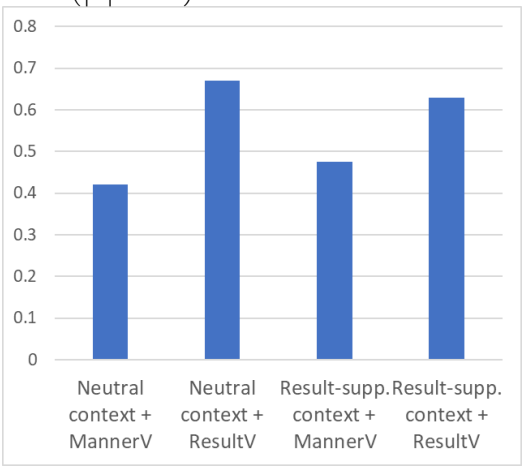

Figure 2: Proportion of result-related continuations (all types)

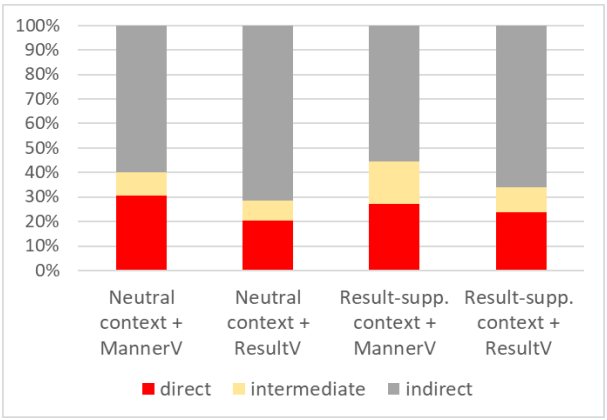

Figure 3: What kind of result?

Discussion: Overall, resultVs elicit more result continuations than mannerVs. For resultVs, these continuations are more likely to be about an *indirect* result that follows from the change-of-state caused by the action. That is, people are more likely to "skip over" mentioning a result state already lexicalized in the verb. We interpret this in light of other work showing that 'unnecessary' repetition carries a processing cost: e.g. studies on co-reference with repeated names have often found processing costs on the repeated noun—the *repeated name penalty* (e.g. [2], [4]), which has been attributed to general pragmatic principles (e.g. [1]). If we take our findings to be in line with a dispreference against unnecessary repetition, it strongly suggests that sub-components of verbal semantics are psychologically real and affect people's production choices.

In sum, the presence of a change-of-state subevent in a resultV influences both the comprehension and the production systems: During *comprehension*, it facilitates processing of a result phrase, while in *production*, it makes mention of direct result phrases less preferred. This provides insights into the mechanisms related to repetition. Some biases (e.g. dispreferring repetition) may guide production more than comprehension because production often involves deciding between options and can trigger more engagement/deeper processing ([3]). In terms of context effects, we find facilitatory effects of context in on-line comprehension (Exp.1) but not in production (Exp.2), perhaps due to our off-line task.

References: [1] Almor '99. Noun-phrase anaphora and focus: The informational load hypothesis. *PsychRev.* **[2]** Gordon et al. '93. Pronouns, names, and the centering of attention in discourse. *CogSci.* **[3]** Hintz & Meyer '15. Prediction and production of simple mathematical equations. *PloS One.* **[4]** Ledoux et al. '07. Coreference and lexical repetition. *Mem & Cog.* **[5]** Rappaport Hovav & Levin '95. Unaccusativity: At the syntax-lexical semantics interface. **[6]** Rappaport Hovav & Levin '98. Building Verb Meanings. **[7]** Talmy '91. Path to realization: A typology of event conflation. *BLS.*