

Objectives and background: retrieving what could have been said

- It is well established that processing long-distance dependencies requires online memory retrieval. The candidates for retrieval are often (implicitly) assumed to only include previously parsed linguistic material that was part of the input [1].
- A different line of research on memory recall, however, has suggested that memory retrieval is also simultaneously a "regeneration" or "re-production" process [2]. This raises the question whether online memory retrieval can also target "what could have been said".

The empirical probe: voice mismatch under ellipsis

Verb phrase ellipsis (VPE) resolution is strongly conditioned by identity (syntactic or semantic) between the antecedent and ellipsis clauses [3].

Jack wrote the advertisement. David did too. (Voice match)

*Jack wrote the advertisement. The poster was too. (Voice mismatch)

VPE constructions that lack identity, including those involving voice-mismatch, have shown gradient instead of categorical acceptability judgments. Discourse coherence [4], information structure [5], and processing strategies [6, 7] have all been proposed to account for the gradient acceptability.

We explore the possibility that at least part of the gradient acceptability arises from the memory retrieval process itself, due to the influence of "what could have been said".

Experiment 1: the production baseline for active vs. passive structures

Experiment 1 replicated previous results in [8] to establish two classes of verbs (Experiencer and Regular) that have different production preferences for active and passive structures.

- Thirty-two pairs of word triplets were adopted and modified from Ferreira (1994), e.g. for an experiencer verb "Jack, advertisement, anger" and for a regular verb "Jack, advertisement, write".
- Examples of experience verbs we used: lure, amaze, impress, frustrate, excite, etc. Examples of regular verbs we used: label, complete, mute, finish, reject, etc.
- Participants (N=50, MechanicalTurk) were given two NPs and one verb and were instructed to create a full sentence. The verb was always the last element in the string and the order of the two NPs was randomized across trials.

Experiment 2: Acceptability Judgments

- Participants (N=50, Mechanical Turk) rated acceptability (1-7 scale) on sentences (item N=32) like the example below.
- 2x2x2 design: the voice feature at the ellipsis site (active vs passive); the structural match between the antecedent and the ellipsis site (voice match vs. mismatch); and the type of verb in the antecedent clause (experiencer vs. regular verbs, the verbs are identical as Experiment 1).

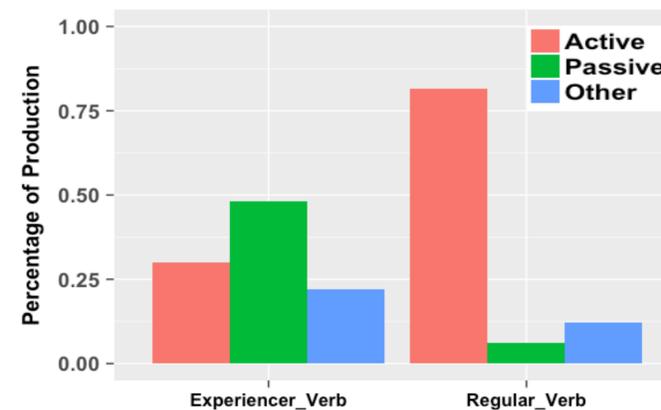
Regular verb antecedent

- Jack wrote the advertisement. David did too. (active-active)
 - Jack wrote the advertisement. The quote was too. (active-passive)
 - The advertisement was written by Jack. The quote was too. (passive-passive)
 - The advertisement was written by Jack. David did too. (passive-active)
- Experiencer verb antecedent
- The advertisement angered Jack. The quote did too. (active-active)
 - The advertisement angered Jack. David was too. (active-passive)
 - Jack was angered by the advertisement. David was too. (passive-passive)
 - Jack was angered by the advertisement. The quote did too. (passive-active)

Results for Experiment 1 and 2

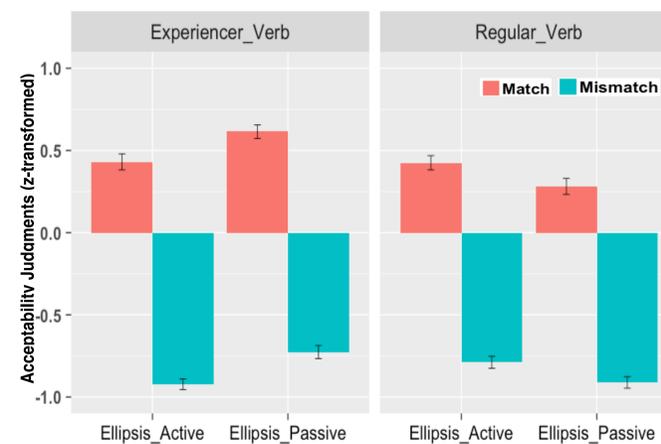
Experiment 1 results: Frequency of producing active, passive and other structures:

- significant effect of verb type ($p < .0001$)
- Participants produced predominantly active structures for the regular verbs, but many more passive structures for the experiencer verbs.



Experiment 2 results: Acceptability judgments (z-transformed):

- There is an expected penalty for mismatch on all voice mismatch conditions (Match vs. Mismatch, $p < .0001$).
- There is also a significant Verb x Voice interaction ($p < .001$): with an experiencer verb antecedent, the ellipsis site prefers passive voice; but with a regular verb antecedent, ellipsis prefers active voice.

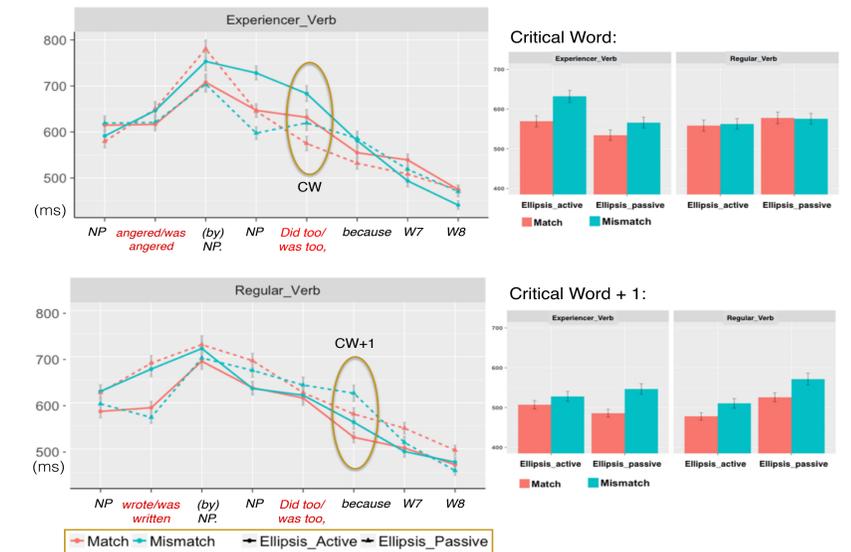


The interaction between the voice at the ellipsis site and the antecedent verb type is consistent with the production bias of the two types of verbs:

- Experiencer antecedent verbs could have triggered the regeneration of the alternative passive structures, hence facilitating the passive ellipsis site.
- Regular antecedent verbs favor active structure in production, facilitating the active ellipsis site.

Experiment 3: Self-paced reading

Experiment 3 (subj N=78) is a self-paced reading experiment examining the time course of the effect observed in Experiment 2. We modified stimuli from Experiment 2 by adding additional material following the ellipsis site, e.g. "Jack wrote the advertisement. David did too, because David enjoyed marketing".



Mixed effects models on the CW and CW+1 regions showed that:

- at the CW, for the Experiencer verb conditions, there was an effect of Voice-Match ($p < .01$), such that the mismatched conditions were read slower than the voice matched conditions. There was also an effect of the voice feature at the ellipsis site, such that conditions with passive features at the ellipsis site were read faster than those with active features at the ellipsis site ($p < .01$), regardless of the antecedent-ellipsis feature match. There were no effect for the Regular verb conditions at the CW.
- The effect for the Regular verb conditions, however, showed up on CW+1. There was an effect of voice mismatch penalty ($p < .01$). This time, conditions with active features at the ellipsis site were read faster than those with passive features ($p < .01$), regardless of the antecedent-ellipsis feature match.

Discussion and conclusion

Establishing the antecedent-ellipsis relationship is affected by the alternative structures with which the antecedent could have been expressed :

- If the antecedent verb prefers passive over the active structure (e.g. with experiencer verbs), this facilitates the processing of ellipsis sites with passive voice; the opposite patterns were observed if the antecedent verb prefers active over the passive structure (e.g. with regular verbs).
- This effect cuts across the factor whether structural identity holds between the antecedent and the ellipsis site. The effect is also present in online measures (SPR). It therefore appears that the influence of production alternatives from the antecedent is not a secondary strategy after the parser fails to establish identity.
- By incorporating production into the memory retrieval process, our findings provide a mechanistic link between production and comprehension. The proposal provided mechanistic instantiation to the "noisy channel" approach [9] to comprehension in general, and the "repair"-based analysis to voice mismatch under ellipsis in particular [7]. We also extend previous work that discussed the memory retrieval mechanism in ellipsis resolution [10].