

Asymmetric processing effects of intra-sentential explanation coherence



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Coherence in Sentence Processing

A crucial task for comprehenders to understand discourse is determining **coherence relations** between linguistic units:

- Comprehenders can **generate expectations** about **coherence relations** between sentences [1][2][3] and relative clauses [4], reflected in, e.g., **faster processing** when text matches coherence expectations.
- E.g., *The boss fired the employee who was [late]_{causal-faster}/[tall]_{neutral-slower}*
- Coherence effects were found in **rereading times/total reading times** [4][5].

Intra-sentential coherence has also been observed but not explored experimentally:

- E.g., *A jogger/teacher was hit by a car.* → ‘hit while jogging/*teaching’ [6]
- Prior work using **self-paced reading** found initial evidence that resultative adjectives affect offline comprehension, **but not online processing** [7][8].

★ QUESTION

- Will **intra-sentential explanation coherence driven by resultative adjectives** (e.g., *broken, injured*) affect sentence processing?
- Specifically, can we find online effects in **later eye movement measures**?

Causality, Temporal Relation and Topichood

Causal relations depend on **temporal relations**:

(1) The broken window was struck by a stone.

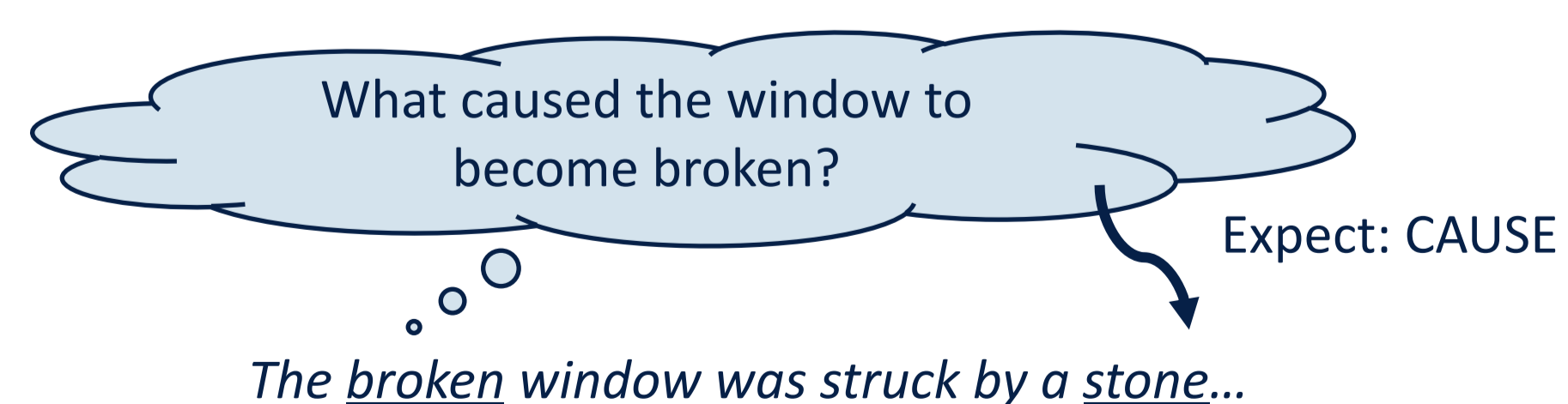
- To permit an explanation relation between the resultative adjective and the verb, the NP (*the broken window*) needs to be **temporally independent**.
- Topics** can be interpreted outside the scope of an event quantifier [9], while subjecthood and definiteness modulate whether the NP can be the topic of the sentence.
- Definite NPs** are **presuppositional** and can serve as topics when they are **subjects** [10][11]. E.g., sentences in the **Passive-Definite** condition may be interpreted as (a) while others may be interpreted as (b):

(a) $\exists x[\text{window}(x) \& \exists s[\text{broken}(s) \& \text{In}(s,x)] \& \exists e[\text{strike-with-a-stone}(e) \& \text{Theme}(e,x)]] \rightarrow e_s = e$
 (b) $\exists e[\text{strike-with-a-stone}(e) \& \exists x[\text{Theme}(e,x) \& \text{window}(x) \& \exists s[\text{broken}(s) \& \text{In}(s,x)]]] \rightarrow e_s < e$

Hypotheses & Design

Main Hypothesis: Resultative adjectives can give rise to intra-sentential causal coherence relations, perhaps by raising the sub-QUD, ‘What event caused this state?’

- The resultative adjective may trigger an **expectation** for an upcoming explanation, which facilitates **online processing**, maybe in a **later stage**.



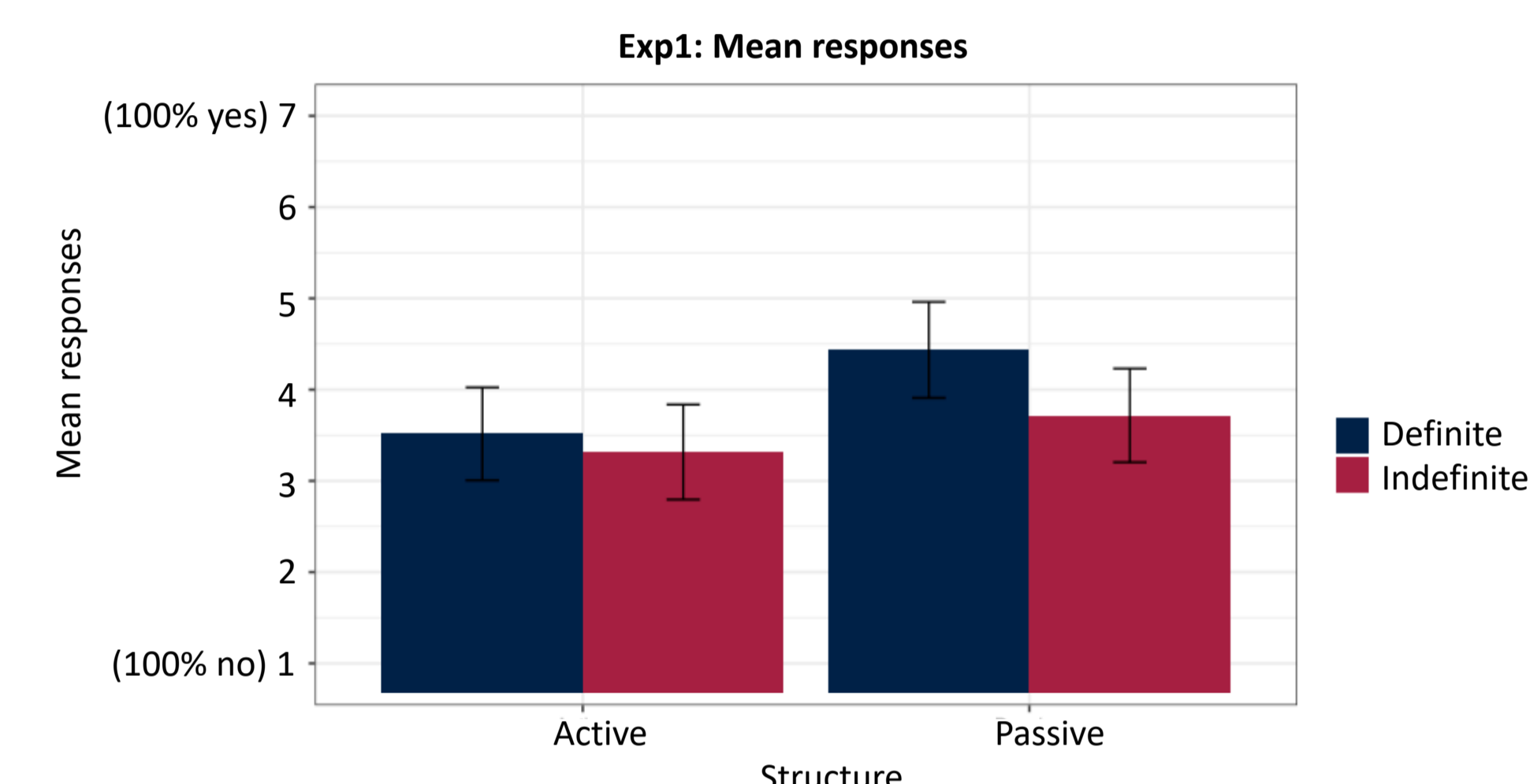
Design:

- Structure** (Passive/Active) x **Definiteness** (Definite/Indefinite)
- Verbs with instrumental PP complements
- 40 experimental items mixed with 80 fillers

Results

Comprehension Task (N = 64)

- 7-point Likert scale, where 1 = definitely no, 7 = definitely yes; Prolific-recruited participants.
- Prediction: The **Passive-Definite** condition would receive **higher** scores than others.



Fixed Effects in Cumulative Link Mixed Model

	Est	SE	z	Pr (> t)
Structure	0.58	0.14	4.23	<.001***
Definiteness	0.40	0.10	3.81	<.001***
Interaction	0.44	0.21	2.15	.032*

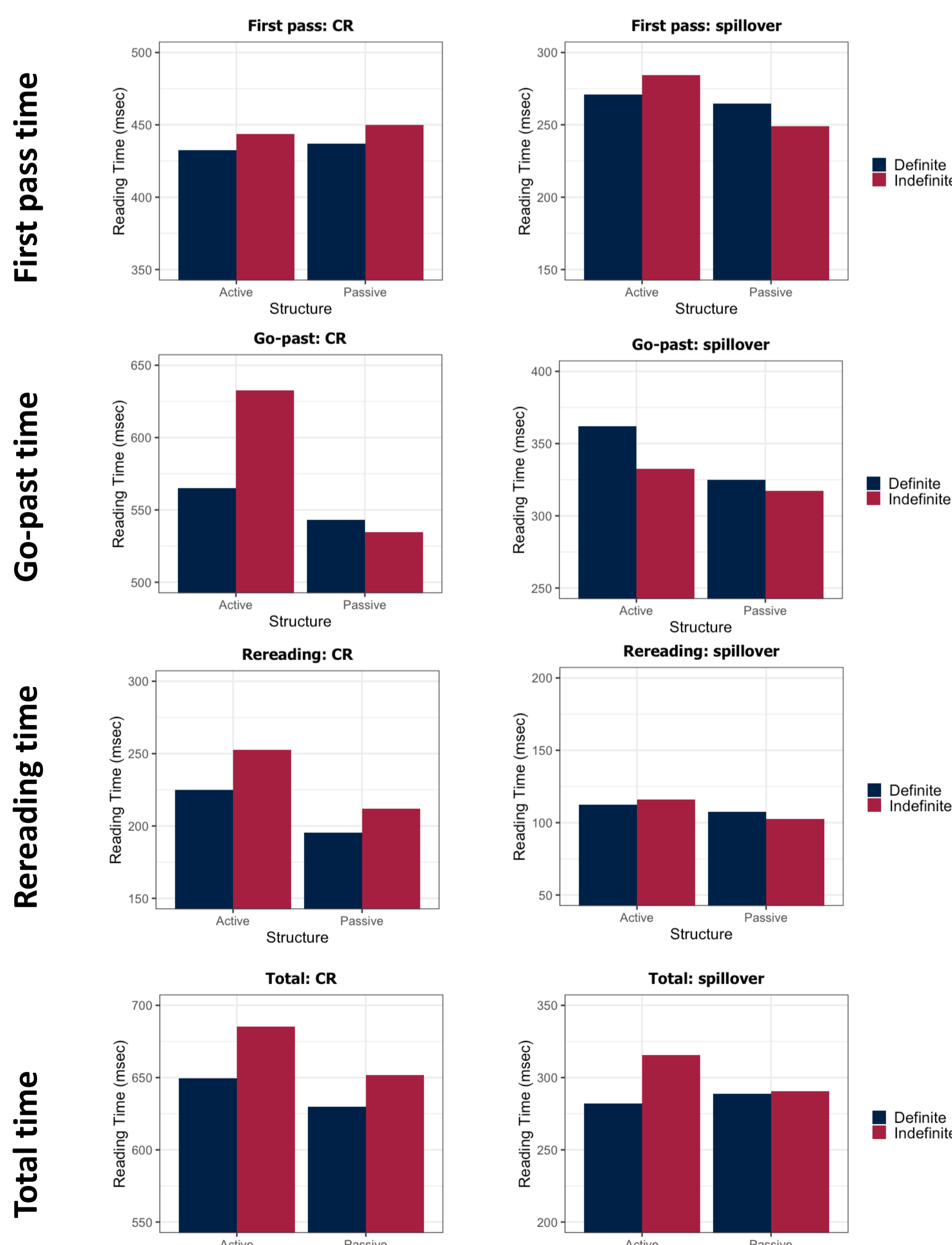
Pairwise Comparisons

Contrast: Definite - Indefinite	Est	SE	z	Pr (> t)
Active	0.20	0.12	1.64	.1008
Passive	0.72	0.20	3.54	<.001***

- Explanation inference was **strongest** in the **Passive-Definite** condition, as we predicted:
 - Suggests that comprehenders used Definiteness and Structure as cues when establishing Explanation relations in offline processing.

Eye-tracking-while-reading (N = 24)

- Region-by-region; critical region (CR): PP (e.g., *with a stone*).
- Prediction: The **Passive-Definite** condition would be read **faster** than others; particularly, we expect to see an **interaction in rereading times and/or total reading times**.



Fixed Effects in Linear Mixed Effects Model in CRs

First-pass	Est	SE	t	Pr (> t)
Structure	5.12	18.51	0.28	.784
Definiteness	-12.02	15.59	-0.77	.448
Interaction	-1.52	28.39	-0.05	.958

Go-past	Est	SE	t	Pr (> t)
Structure	-62.22	56.17	-1.11	.279
Definiteness	-31.44	42.71	-0.74	.469
Interaction	72.83	86.66	0.84	.410

Rereading	Est	SE	t	Pr (> t)
Structure	-35.19	25.34	-1.39	.180
Definiteness	-22.14	23.88	-0.93	.359
Interaction	11.01	42.53	0.26	.796

Total	Est	SE	t	Pr (> t)
Structure	-26.58	27.64	-0.96	.350
Definiteness	-28.71	24.76	-1.16	.253
Interaction	14.34	46.55	0.31	.759

- Prediction: **No interaction** was found in either CRs or spillovers in any measures, contra our prediction:
 - Suggests establishing Explanation relation does not speed real-time processing.
 - May indicate that comprehenders do not establish intra-sentential coherence in online processing.

Sample Item

Structure	Definiteness	Coherence (expected)	Sentence
Passive	Definite	Yes	The broken window/got struck/with a <u>stone</u> /from the/sidewalk/next to the/building.
Passive	Indefinite	No	A broken window/got struck/with a <u>stone</u> /from the/sidewalk/next to the/building.
Active	Definite	No	Bethany/struck/the broken window/with a <u>stone</u> /from the/sidewalk/next to the/building.
Active	Indefinite	No	Bethany/struck/a broken window/with a <u>stone</u> /from the/sidewalk/next to the/building.
Question	Do you think the window became broken because it got struck with the stone?		

* Slashes represent splits of regions in the eye-tracking.

General Discussion

The **asymmetry** between the offline study and the online study suggests:

- Comprehenders do not incrementally establish coherence relations between resultative adjectives and the related events.
- Perhaps comprehenders are **unable to rapidly raise a relevant QUD** from informationally **backgrounded** elements (i.e., attributive adjectives), which may guide online coherence effects in more standard inter-sentential cases (e.g., *The window was broken. It was struck by a stone.* → ‘The window was broken because of the stone’).
- Comprehenders can establish such relations in Exp 1 because they were **cued by comprehension questions** that prime them to think about the QUD.

Future research

- Our more recent study, which manipulated matrix IC verbs and RC IC verbs, provided further evidence to confirm backgroundedness is driving these asymmetric effects.
- Future research may also investigate potential online effects when comprehenders are cued by a relevant QUD overtly.

References

[1] Rohde, H. (2008). *Coherence-driven effects in sentence and discourse processing*. University of California, San Diego. [2] Grüter, T., Takeda, A., Rohde, H. & Schafer, A. J. (2018). Intersentential coherence expectations reflect mental models of events. *Cognition*, 177, 172–176. [3] Hoek, J., Rohde, H., Evers-Vermeul, J. & Sanders, T. (2020). Scolding the child who threw the scissors: Shaping discourse expectations by restricting referents. *Language, cognition and neuroscience*. [4] Hoek, J., Rohde, H., Evers-Vermeul, J. & Sanders, T. J. (2021). Expectations from relative clauses: Real-time coherence updates in discourse processing. *Cognition*, 210(1), 104581. [5] Scholman, M. C., Rohde, H. & Demberg, V. (2017). “on the one hand” as a cue to anticipate upcoming discourse structure. *Journal of Memory and Language*, 97, 47–60. [6] Hobbs, J. R. (1990). *Literature and cognition* (No. 21). Center for the Study of Language (CSLI). [7] Sasaki, K., & Altshuler, D. (2023). Clause-internal coherence: A look at deverbal adjectives. *Proceedings of Sinn und Bedeutung* (Vol. 27). [8] Yao, R., Sasaki, K., Altshuler, D. and Husband, E.M. (2023). Explanation coherence inside sentences, but only offline. The 36th HSP Poster. [9] Herburger, E. (2000). *What counts: Focus and quantification*. MIT Press. [10] Musan, R. (1999). Temporal interpretation and information-status of noun phrases. *Linguistics and philosophy*, 621-661. [11] Gundel, J. K., & Fretheim, T. (2004). Topic and focus. *The handbook of pragmatics*, 175(196), 12.