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Incremental interpretation of clause-internal coherence: Evidence from the Maze

Introduction. A vital part of interpreting language is the recovery of coherence, i.e., how a series of utterances fit together to form a coherent story. Research in pragmatics has, accordingly, explored *discourse-level coherence*, which forms the basis for formal theories of discourse structure. However, Hobbs (2010) proposed that coherence inferences also manifest within a clause (e.g., *A jogger was hit by a car* ➦ the car hit a person while the person was jogging). Cohen & Kehler (2021) argue that these *clause-internal coherence* (CIC) inferences represent cases of pragmatic enrichment, which they term *eliciture*, that are distinct from familiar types of enrichment such as Grice's (1975) implicatures and various forms of local pragmatic strengthening (Levinson 1987; Recanati 2010). Recent experimental research provides offline evidence that speakers can draw CIC inferences from adjectives (Sasaki & Altshuler 2022, 2023; Yao et al. 2024) and nouns (Sasaki et al. forthcoming). However, those studies probed untimed, introspective judgments, and explicitly prompted readers with the key CIC interpretation (e.g., given the sentence *Bob congratulated a winner (Alice)*, participants were asked, *How likely do you think it is that Bob congratulated Alice because she was a winner?*). To our knowledge, only one study (Yao et al. 2023) has tested online, unprompted CIC processing. In a self-paced reading task involving resultative adjectives (e.g., *a broken window*), Yao et al. found no evidence that causal CIC inferences are built incrementally. In the current study, we test for online causal CIC inferences in another paradigm. We show that nouns can indeed be rapidly integrated into CIC inferences when tested via the Maze task, which may provide a clearer picture of online CIC processing than self-paced reading by forcing participants into a more incremental mode of processing and avoiding spillover effects (Forster et al. 2009).

Experiment. We used the Maze task paradigm to investigate whether CIC causal inferences in English are integrated incrementally. Materials consisted of two-clause passages (32 items) where the first clause contained a potential inference of a CIC Explanation relation ('x because y') and the second clause provided an explicitly-marked Explanation (Table 1). The goal was to establish whether readers rapidly identified the potential CIC inference within the first clause and, if so, whether they were surprised to encounter a subsequent Explanation in the second clause. We manipulated (i) the availability of a potential CIC inference in the first clause, whereby the direct object noun did or did not evoke a plausible cause of the situation described by the verb {CAUSAL, NON-CAUSAL} and (ii) the transparency of the event evoked by the noun via its morphological status {DEVERBAL, NON-DEVERBAL}. The second clause provided an Explanation for the situation in the first clause, marked by an explicit *because* connective. The first clause situations were derived from a set of 44 items adapted from those in Sasaki et al.'s (forthcoming) offline studies. Through a norming study (N=36), we verified that the two clauses—with a proper name in place of the critical noun (e.g., *Alice* in place of *winner*) and without an explicit *because* connective—robustly gave rise to a causal coherence inference.

In the Maze task, participants advance incrementally through a sentence by choosing between two words at each point; only one is a valid continuation (Forster et al. 2009) (Table 1). If comprehenders construct CIC relations incrementally and without explicit prompting, we expect a causal advantage at the critical noun (shorter response times for CAUSAL nouns), in line with many previous findings for cross-clausal coherence processing (Hoek et al. 2021a,b). This predicted pattern may hold across noun types or else be more robust when the noun offers more transparent access to the relevant causal situation (stronger causal advantage for DEVERBAL nouns). Furthermore, following Hoek et al.'s (2021b) findings for coherence processing involving relative clauses, we expect that, if comprehenders rapidly commit to a clause-internal Explanation—before encountering the *because*-clause—then they should have a lowered expectation, or no expectation, of another Explanation. Thus, at the connective *because*, we expect longer response times in the CAUSAL condition, in which the direct object

in the first clause has already provided a plausible Explanation, compared with the NON-CAUSAL condition, in which readers may still be expecting an Explanation of the situation described in the first clause.

Log-transformed response times from 36 native English speakers recruited via Prolific were analyzed using maximal Bayesian linear mixed-effects regression models. At the critical noun, as predicted, response times (Figure 1) were shorter for CAUSAL nouns than NON-CAUSAL nouns (β= -0.13, CrI=[-0.20, -0.06]). At the connective *because*, the predicted slowdown for the CAUSAL condition was not entirely borne out; instead, there was an interaction such that the CAUSAL slowdown was observed only in passages with DEVERBAL nouns: Response times in the CAUSAL DEVERBAL condition were longer than in the NON-CAUSAL DEVERBAL condition (β= 0.07, CrI=[0.01, 0.13]), while the NON-DEVERBAL passages showed no difference between CAUSAL and NON-CAUSAL.

Discussion. One might wonder whether the apparent causal advantage at the noun can be explained by the relative frequencies of the verb-noun collocations (e.g., *congratulate-winner/champion* collocations are more frequent than *congratulate-reader/bookworm* collocations). It may indeed be the case that the CAUSAL passages have systematically higher verb-noun collocation frequencies than the NON-CAUSAL passages. However, the question then arises as to why collocation frequencies would show that pattern in the first place. If there is something cognitively special about causal coherence—versus any sort of coherence—perhaps that specialness is in fact what boosts the collocation frequency of *congratulate–winner/champion*. To further test for CIC inferences independent of collocation frequencies, future work could target Violated Expectation inferences, which have the advantage of favoring infrequent verb-noun collocations (e.g., *congratulate the loser*). If there is evidence of CIC inferences in such cases, the results would rule out an account based on surface collocation frequencies, in support of one that relies on deeper coherence-driven reasoning.

Conclusion. Using the Maze task, we showed that nouns can be rapidly integrated into CIC inferences, providing the first evidence that causal CIC inferences are built incrementally.

Table 1: Stimuli from Maze experiment.

CIC Inference	Noun Type	Text
(a) CAUSAL	DEVERBAL	Alice congratulated two winners this morning because last night they each broke a world record.
(b) NON-CAUSAL	DEVERBAL	Alice congratulated two readers this morning because last night they each broke a world record.
(c) CAUSAL	NON-DEVERBAL	Alice congratulated two champions this morning because last night they each finished ten long chapters.
(d) NON-CAUSAL	NON-DEVERBAL	Alice congratulated two bookworms this morning because last night they each finished ten long chapters.
Foils		x-x-x heterogeneous door crowding goal anymore biggest are worry say solution fund is hates movies.

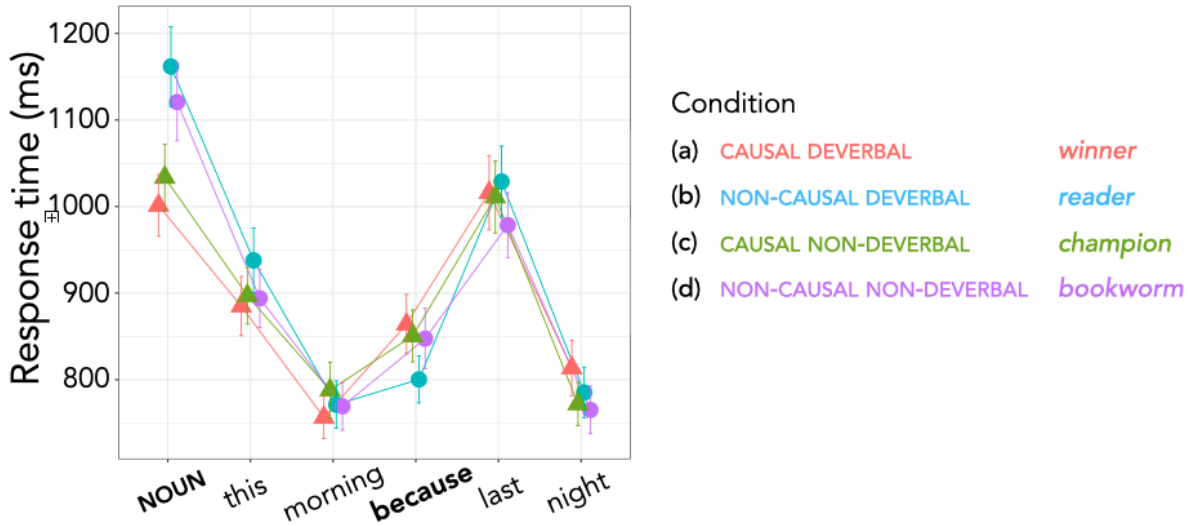

Figure 1. Mean response times for critical words (NOUN and *because*) and their spillover regions. Error bars show a 95% CI.

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