

Connecting events: an ERP study of causal connectives

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During language comprehension, the sequence with which events unfold does not necessarily mirror their real-world sequence (where causes precede effects). Moreover, comprehenders may not receive explicit cues (e.g. discourse connectives) indicating event order. In two event-related potential (ERP) experiments, we asked how, despite these challenges, comprehenders are able to incrementally draw upon their stored real-world knowledge about causal relationships between events brain to maintain causal coherence during word-by-word discourse processing.

In **Experiment 1**, 32 participants read two-clause sentences. We manipulated the canonicity of events, and their causal coherence. The second clause was linked to the first by a forward causal connective (“and so”) or a backwards causal connective (“because”); the second clause contained a critical word that was causally coherent or incoherent (e.g., The river flooded **and so/because** the town was *destroyed*...; The town was destroyed **because/and so** the river *flooded*...). Results: (a) ERPs at the connective revealed a larger frontal negativity between 350-500ms to “because” than “and so”. At left frontal sites, this negativity effect remained significant on the subsequent word. (b) ERPs on the critical word revealed an effect of coherence on the N400. This effect was not modulated by type of causal connective (“and so” versus “because”).

In **Experiment 2**, 30 different participants read a new set of two-clause coherent scenarios. We manipulated the canonicity of the event sequence and the presence/absence of a connective. The second clause was linked to the first either by “and so”, “because” or by a semicolon (e.g., The cleaners mopped the floor **and so/because/;** it looked very tidy/slimy...). Results: (a) Replicating Experiment 1, the first word of the second clause evoked a larger frontal negativity following “because” than “and so”. Moreover, consistent with studies of non-canonical temporal connectives, this larger frontal negativity was sustained across all words in the second

clause. In the no-connective scenarios, the words of the second clause also evoked a larger frontal negativity than in the “and so” scenarios. (b) On the critical word, the amplitude of the N400 was not modulated by the type of causal connective (“and so” versus “because”) or by the presence/absence of a connective.

Conclusion: We suggest that the sustained anterior negativity effect reflected the increased demands of retaining an event representation of the first clause within working memory while processing words of the second clause. These increased costs were incurred both when comprehenders were explicitly cued to predict non-canonical event sequences (following “because”), and when there was uncertainty about whether events would appear in canonical or non-canonical order (no causal connective), but not when comprehenders were explicitly cued to predict a canonical event sequence. We suggest that this ability to retain the event representation of the first clause over time within working memory is what allows comprehenders to quickly draw upon their stored real-world causal knowledge to facilitate processing of causally coherent incoming words (as reflected by N400 modulation), even when the sequence of upcoming events conveyed by upcoming linguistic input is non-canonical or uncertain.