

When effects appear before cause: An ERP study

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The sequence in which causally related events unfold during language comprehension does not necessarily mirror the sequence with which they unfold in the real world.

Sometimes comprehenders receive explicit cues (e.g. discourse connectives) telling them whether to *expect* a canonical or non-canonical event sequence.

Here we focused on the use of *causal discourse connectives* that either cue a forward canonical event sequence ("and so") or a backward non-canonical event sequence ("because"). We used ERPs to ask how these connectives influence (a) load on working memory (indexed by a frontally-distributed sustained negativity) and (b) semantic facilitation (indexed by the centro-parietally-distributed N400) during word by word comprehension.

Experiment 1

Methods:

Connective Type

Forward (and so)

Backward (because)

Predictability/
coherence of CW
predictable
unpredictable

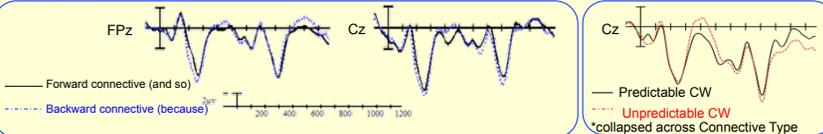
The river flooded and so the town was destroyed ...
The town was destroyed and so the river flooded ...

The town was destroyed because the river flooded ...
The river flooded because the town was destroyed ...

45 scenarios per condition
45 non-causal filler sentences per list
Coherence judgment task
32 participants

CW: critical word is underlined

Results:



ERPs on connective: "because" evoked a larger widespread negativity than "and so" ($p < 0.03$). This effect remained significant on the subsequent words at frontal sites ($p < 0.05$).

➔ An increased WM load as comprehenders prepared to process the second clause following the backward (vs. forward) connective. This suggests that "because" cued comprehenders to predict a non-canonical event sequence, which led them to retain the event representation of the first clause within WM in order to integrate it with event representation of the second clause as it unfolded in real time.

ERPs on critical word: Smaller N400 on predictable/coherent than unpredictable/incoherent critical words ($p < 0.001$). Magnitude of N400 effect was not influenced by the nature of the connective (no interaction between Predictability/Coherence and Connective Type).

➔ Causal expectations based on canonical sequencing did not influence semantic facilitation of incoming words.

Experiment 2

Methods:

Real-world event sequence

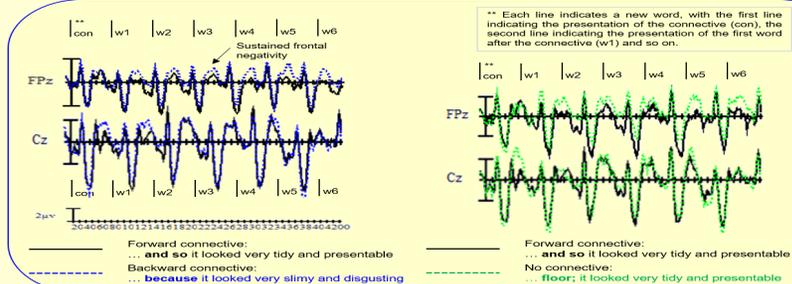
Forward (canonical)

Backward (non-canonical)

Connective Presence	yes	The cleaners mopped the floor <i>and so</i> it looked very <u>tidy</u> ...	The cleaners mopped the floor <i>because</i> it looked very <u>slimy</u> ...
	no	The cleaners mopped the floor; it looked very <u>tidy</u> ...	The cleaners mopped the floor; it looked very <u>slimy</u> ...

38 scenarios per condition
(+ an additional condition)
Coherence judgment task
30 participants

Results:



ERPs on first word of the second clause: Larger frontal negativity following "because" and following no connectives, relative to following "and so".

This frontal negativity persisted across all the words in the second clause.

➔ Readers incur a sustained WM load both when they are (a) explicitly cued to predict a non-canonical event sequence (following "because"), and (b) uncertain about the causal or temporal relationship of upcoming events (absence of any connective cue).

ERPs on critical word: No N400 difference in contrasting connective vs. no-connective scenarios.

➔ The presence/absence of causal connectives did not influence semantic facilitation.

Conclusion

- Both the type of causal connectives (cueing non-canonical vs canonical event sequences) and the presence or absence of causal connectives, influence the WM load incurred during word-by-word comprehension. BUT
- Neither of these factors influence the degree to which readers draw upon their stored real-world knowledge about causal relationships across events to anticipate upcoming events, thereby facilitating semantic processing of incoming words.

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