

Temporal proximity between causes and effects influences patterns of causal attribution

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Theories of discourse processing have stressed that successful discourse comprehension involves monitoring changes in the narrative's temporal and causal dimensions while building situation models about the series of eventualities described in narratives (Zwaan & Radvansky, 1998). However, it is still unknown to what extent these dimensions interact. In this paper, we present evidence suggesting that readers' expectations about causal attribution (*who* caused an event) change depending on the temporal proximity between causes and effects.

In two production experiments, we manipulated temporal proximity between causes and effects, which we hypothesized to lead to different expectations about the agent of the cause. In Experiment 1, we collected discourse-continuations for 124 narratives involving interpersonal present-tense-marked German verbs and 2 gender-different entities, followed by the causal connective *because* (1), and annotated them for pronominal reference and temporal location of the elicited explanations. We observed an effect of proximity on the pronominal referent choice ($p < 0.0001$): distal explanations (marked with past/perfect tense) were more likely to refer back to the second-mentioned NP in the prompt (NP2), while proximal explanations (marked with present tense) were more likely to refer to the first-mentioned NP (NP1).

- (1) *Karla findet Maxim, weil _____* (only in Exp. 2: *heute/gestern _____*).
Karla find-3SG.PRES Maxim because _____ (today/yesterday _____).

Experiment 2 used implicit causality (IC) verbs, which have associated biases regarding the causal agent (Garvey & Caramazza, 1974, Rudolf & Försterling, 1997). Verbs can have biases toward NP1 (*frighten*), NP2 (*congratulate*), or no bias (*search*). We used a 3x2 design manipulating the explanation's temporal proximity (proximal/distal as marked by a temporal adverb) against the verb's IC-bias. We annotated for pronominal reference, and measured conceptualization time (the time to evoke a plausible continuation) using E-Prime. We found that causal attribution patterns differ as a function of IC type ($p < 0.001$) and proximity ($p = 0.02$). Simple-effects tests reveal that while proximity has no effect on NP2 verbs ($p = 0.87$), it shifted causal attribution patterns for NP1 verbs ($p = 0.04$; NP1-bias weakens in distal conditions) and non-IC verbs ($p = 0.03$; NP2-bias emerges in distal conditions). Conceptualization time varied as a function of IC type ($p = 0.001$) and proximity ($p = 0.001$): participants spent more time a) evoking plausible explanations for events involving NP1 verbs than NP2 verbs; and b) thinking about distal than proximal explanations. We also observed a marginally significant interaction between IC type and proximity ($p = 0.056$): the difficulty involved in evoking distal explanations was more pronounced for NP1 verbs than for NP2 verbs.

Our research demonstrates that a narrative's temporal/causal dimensions are not independent: readers' expectations about the causal agent shifted depending on the temporal information they encountered. Causal expectations seem to have temporal constraints: with NP1 verbs, readers preferred to attribute the cause to the effect's agent (NP1) only if the cause was proximal. Our results are congruent with discourse-based accounts of IC (Kehler *et al*, 2008; Bott & Solstad, 2013), where IC-biases are modulated by discourse-driven expectations (i.e., expectations about temporal proximity between causes and effects).

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