Order, relevance and script knowledge: Revising temporal structures

Conjunctive sentences that report two past events tend to suggest that the events happened in the order of mentioning. In Gricean framework this phenomenon is described as *temporal implicature*, by referring to the Maxim of Manner, that requires interlocutors to be "orderly" in their communication. Other authors have argued that it is not a purely pragmatic phenomenon [2, 1], and that the temporal implicature may result from a more general structure of our narration, whereas "and" is a connective that maintains the narrative coherence [3, 4].

It is still an open question to what extend the temporal representation of events as observed in the real life modulates the linguistic processing, in particular, whether the temporal information enters the compositional semantic representation of the linguistic input and whether it modulates the predictive processing in language. The role of the contextual relevance of the temporal order for the temporally structured linguistic report has not been yet well-investigated either.

In two ERP experiments I investigate the effect of the temporal order violation in conjunctive reports, in contexts where the order is based only on the presented scenario. The experimental paradigm resembles a memory game, in which participants assign points to a virtual player and read sentences describing the game events. There are two categories of cards: animal and non-animal cards. In each trial, four cards are dealt and the player flips two of them. Afterwards, the participant assigns points based on the cards' categories and the order in which they were flipped. In Experiment 1, the game rules are defined as follows: If the player flips two cards from the same category, then she gets 1 point. If she flips two cards from different categories, then the points depend on the cards' order. Thus, in the **Same Category** condition, the order of the cards is irrelevant for the points assignment, whereas in the **Mixed Category** condition, the points depend on the order. After the points are given, a sentence is presented word-by-word describing the game trial, e.g. *Julia hat eine Katze und eine Blume umgedreht* (*Julia has flipped a cat and a flower*), either in the **Correct** or in the **Reversed Order** (Figure 3).

A significant late positivity (P600) effect is observed for the Reversed relative to Correct Order conditions at the first noun at which the order violation can be detected, for both Category conditions (Same and Mixed). In addition to the P600 effect we observe a modulation of the N400 by Order: Reversed Order conditions elicit more negative N400 ERPs that Correct Order conditions.

In Experiment 2, the same conditions are used (Mixed vs. Same Category pairs, Correct vs. Reversed sentences); however, the number of points in a trial only depends on whether the cards come from the same category or not. A significant P600 effect is observed for the order violation; however no robust modulation of the N400. The experiments show that, irrespectively of whether the attention is directed towards the order as contextually relevant, the violation of the order in the linguistic report engages reprocessing mechanisms, presumably linked to revising of the temporal structure of the constructed model, as indicated by the P600 effect. The N400 appears to be only modulated by order if the order is contextually relevant.

In Experiment 3, the effect of temporal violation is measured in conjunctive sentences that report evens from the real life, such that the temporal relation between the events is part of our script knowledge. For instance, although it is possible to first dry hair and then wash it, it would be very unusual to do so. Based on constructed three-event scenarios, such as *washing, drying, braiding hair*, experimental conditions use two-event sentences that report either the initial or final script-fragment, in correct or reversed order: *She washed her hair and dried it* (**correct initial**), *She dried her hair and braided* (**correct final**), *She dried her hair and washed it* (**reversed initial**) and *She braided her hair and dried it* (**reversed final**). Late positivity is observed for all experimental conditions relative to the correct initial condition. The effect for the reserved vs. correct order conditions is consistent with the result from the two other experiments. The late positivity observed for the correct final condition suggests higher processing costs in constructing the temporal representation in the case of temporally less direct events.

Figure 1: The structure of an example trial from Experiments 1 and 2, representing the **Mixed-Correct** condition. If an animal card is flipped first and then an non-animal card, the player gets 2 points; but if a non-animal card is flipped first and then an animal card, she gets 0 points. To keep participants attention on the content of sentences, filler trials are introduced in which the sentence mentions one card that was not opened in the game. A control question of whether a non-presented card was mentioned follows 25% of all trials.

Julia	hat	eine	Eule	und	eine	Tasse	umgedreht.
250 ms	250 ms	350 ms	500 ms	350 ms	350 ms	500 ms	600 ms
500 ms	500 ms	700 ms	1000 ms	700 ms	700 ms	1000 ms	1000 ms

Figure 2: Comparison of grand averages at CPz location for Experiments 1 and 2 with marked time-windows used on the analysis. Experiment 1: The effect of Order in 450-650 ms: $F(1, 27) = 22.18$, $p < .001$. In 300-540 ms, AP (anterio-posterior distribution) x Order interaction: $F(1, 27) = 11.04$, $p = .003$. Experiment 2: The effect of order 450-650 ms: $F(1, 36) = 13.23$, $p = .001$.

Figure 3: Comparison of grand averages at CPz location for Experiment 3. Late positivity is observed after 600 ms post-onset the second verb. Cluster-based permutation statistics: Correct Final vs. Correct Initial: $p = .007$; Reversed Initial vs. Correct Initial: $p = .049$; Reversed Final vs. Correct Initial: $p = 0.06$.

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