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Order and relevance: Revising temporal structures

It is uncontroversial that humans tend to construct a temporally organized mental representation of events. The way we describe events in language also tends to reflect the chronological order in the real life. For instance, conjunctive sentences that report two past events suggest that the events happened in the order of mentioning: *Julia finished her PhD and got married* suggests that Julia got married after finishing her PhD, whereas *Julia got married and finished her PhD* suggests the reverse order. 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. Since this effect is not exclusive to conjunctive sentences, namely, juxtaposed clauses reporting two past events also tend to be interpreted as temporally sequential, it is argued that the temporal implicature results from a more general property of the discourse or narration structure. Other authors have argued that: (i) it is not a purely pragmatic phenomenon, since the temporal succession is also present for cases of unrelated event reports [2], (ii) "and" is a connective that maintains the narrative coherence and implicates "and then" [3, 4], and finally (iii) events reported by conjunctions create a single complex unit [1].

Many conjunctive sentences describe events that are linked in some way and we often have "script" knowledge regarding the natural order in which the events normally happen (e.g. *She washed her hair and dried it*). However, the events do not need to be related, in which case the only temporal order that is suggested is the order in which the events are mentioned. For example, *Julia read a book and sang a song* reports two events that could happen in any order. Furthermore, the temporal implicature may sometimes not arise, if the order of events is not contextually relevant.

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.

I present results of ERP experiments investigating the effect of the violation of temporal order in conjunctive sentences, 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 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. If an animal card is flipped first and then an non-animal card, the player gets 2 points; if a non-animal card is flipped first and then an animal card, she gets 0 points. 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*). In the **Correct Order** condition, sentences describe the events in the order in which they happened; in the **Reversed Order** condition, the events are described in the reversed order (Figure 2).

Reversed Order conditions show a late positivity (P600) effect relative to Correct Order conditions at the first noun at which the order violation can be detected. This effect occurs both for cases where the order is relevant for the points' assignment (Mixed Category), as well as for cases where the order is irrelevant (Same category); however, an interaction between Order, Category, AP distribution and participants' Reading Span (High vs Low memory groups) is observed. Whereas in the Same Category condition, a robust effect of Order as well as interaction with the reading span is observed, in the Mixed Category condition we only observe an effect of Order. 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, independent on the Same vs. Mixed Category factor.

In a follow-up experiment, the same conditions are used (Mixed vs. Same Category pairs, Correct vs. Reversed sentences); however, the game rules are changed: Both for mixed and same categories pairs, the order of the cards is irrelevant for the assignment of the points and the number of points in a trial only depends on whether the cards come from the same category or not. A similar 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 relevant in the given scenario, respectively in the whole game, the violation of the order in the linguistic report engages reprocessing mechanisms, linked to revising of the temporal structure of the constructed model, as indicated by the P600 effect. The N400 effect observed for the order violation in the design where the order is contextually revelent further suggests that the automatic first-pass processes related to lexical retrieval and lexical prediction are also modulated by the encoded temporal structure.
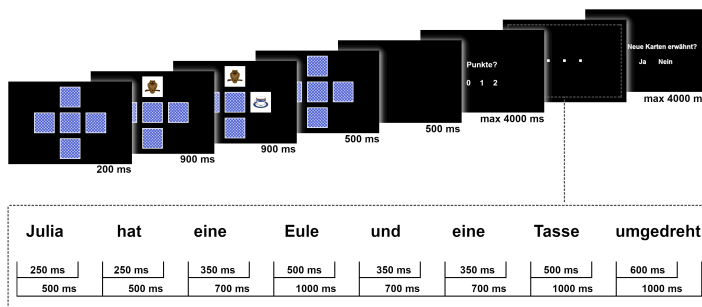

Figure 1: The structure of an example trial representing the **Mixed-Correct** condition. To keep participants attention on the content of sentences, filler trials are introduced in which the sentence mentions one card that was not opened in the game. A control question of whether a non-presented card was mentioned follows 25% of all trials.
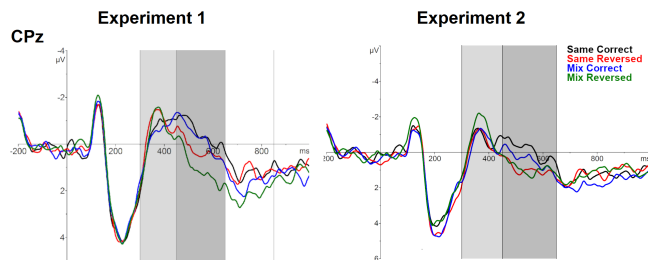

Figure 2: Comparison of grand averages at CPz location for both experiments.

[1] Robyn Carston. *Thoughts and Utterances: The Pragmatics of Explicit Communication.* Oxford, UK: Blackwell, 2002.
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[3] Andrew Kehler. Coherence and the resolution of ellipsis. *Linguistics and Philosophy*, 23.6:533–575, 2000.
[4] Andrew Kehler. Discourse Coherence. In *The handbook of pragmatics*, pages 242–265. Oxford, UK: Blackwell, 2004.