How presentation modality influences reading comprehension

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Three presentation modalities are commonly used in studies investigating language processing during reading: rapid serial visual presentation (RSVP), self-paced reading (SPR), and whole-sentence presentation. In RSVP, words are presented one by one each for a fixed amount of time. This is the most constrained form of reading because it offers no control over viewing times and the order in which words can be inspected. In SPR, the order of words is fixed, too, but the reader has control over viewing times. The least constraining modality is whole-sentence presentation which gives readers full control over viewing times and the order of inspection, including the possibility of skipping and revisiting words. Despite these considerable differences, these presentation methods are widely assumed not to influence comprehension mechanisms differentially and that results found in one modality generalize to other modalities. Here, we test this assumption.

In an online experiment, we presented German undergraduates (N=60) with German sentences that contained either a syntactic violation (mismatch of grammatical gender: the_{MASC} $deteriorated$ $farm_{FEM}$), a world-knowledge violation (*the inquisitive farm*), or no violation, with the task being to judge whether the presented sentences were "*ok*" or not. The violation occurred either at the beginning of the sentence or at the end. If readers use the additional freedom during whole-sentence presentation for more thorough sentence analysis, then that condition should show highest accuracy. However, if they use it to skip word forms highly redundant with other parts of the sentence, then that condition should show differentially low accuracy for syntactic-violation identification. Each participant was randomly assigned to one out of four presentation modalities: RSVP with 300 ms presentation time for each word, 600 ms-per-word RSVP, centered SPR, and whole-sentence presentation. To avoid at-ceiling performance in the judgment task, we presented each experimental sentence together with a second sentence.

Crucially, whole-sentence presentation yielded lower accuracy than other presentation modalities for syntactic violations (78% vs 91%, p<<.001), and accuracy similar to the other modalities for no-violation (ns) and world-knowledge violations (57% vs 58%, p<.01). Irrespective of modality, accuracy was greatly decreased when a world-knowledge violation was present (58% vs 92%, p<<.001) and slightly decreased when a syntactic violation was present (88% vs 92%, p<.001). Presentation modality did not influence the performance in no-violation sentences. However, syntactic violations were judged more accurately in SPR than in the RSVP conditions (95% vs 90%, p<.01).

Since whole-sentence presentation yielded performance similar to that in other modalities in the no-violation and world-knowledge-violation conditions, readers do not seem to have adopted an overall more careless reading strategy. Rather, we suggest that it allowed readers to make a speed-accuracy tradeoff not possible in the other modalities (Bicknell & Levy, 2010; Lewis et al. 2013): Readers are known to often skip highly predictable, short words in normal reading (Rayner, 1998). Thus, they may have skipped the article carrying the crucial gender marking (the_{MASC}) and may therefore not have noticed the mismatch at the noun ($farm_{FEM}$). Under this account, world-knowledge violations were much less affected by modality because there the relevant words were too long to be skipped. In sum, these results demonstrate that presentation modality can strongly interact with key aspects of language processing (see also Schotter et al., 2014). The three tested presentation modalities give readers different degrees of freedom and readers appear to use these freedoms to implement reading strategies tailored to the modality. This finding does not invalidate any of the tested presentation methods but it cautions us that the peculiarities of the reading modality have to be carefully considered when interpreting results from reading experiments.

How Presentation Modality Influences Reading Comprehension

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Background:

Three written presentation modalities used in sentence processing research:
- Rapid serial visual presentation (RSVP, common in ERP research and classic comprehension studies),
- Self-paced reading (SPR),
- Unconstrained, natural reading during whole-sentence presentation.

It is generally assumed that results generalize beyond the tested reading modality, i.e., that effects of modality are orthogonal to the effects of the manipulation of interest. The goal of this study was to test this assumption.

Method:

- Judgment task administered online ("*Was the sentence ok?*").
- 60 German participants from the undergrad population at University of Potsdam.
- Sentences contained a syntactic, semantic, or no violation at the beginning or end of the sentence.
- Sentences were presented in one of four presentation modalities (between-subject):
    - RSVP, 300 ms inter-stimulus interval
    - RSVP, 600 ms inter-stimulus interval
    - centered SPR
    - whole-sentence presentation

Materials:

Control condition (no violation):

Der_{MASC} verfallene $Bauernhof_{MASC}$ braucht eine Renovierung.
The_{MASC} deteriorating $farm_{MASC}$ needs   a   renovation.

Early syntactic violation:

Die_{FEM} verfallene $Bauernhof_{MASC}$ braucht eine Renovierung.
The_{FEM} deteriorating $farm_{MASC}$ needs   a   renovation.

Early semantic violation:

Der_{MASC} neugierige $Bauernhof_{MASC}$ braucht eine Renovierung.
The_{MASC} inquisitive $farm_{MASC}$ needs   a   renovation.

Control condition (no violation):

Der erfahrene   Star spielt die_{FEM} schwierige $Rolle_{FEM}$.
The experienced star plays the_{FEM} difficult $role_{FEM}$.
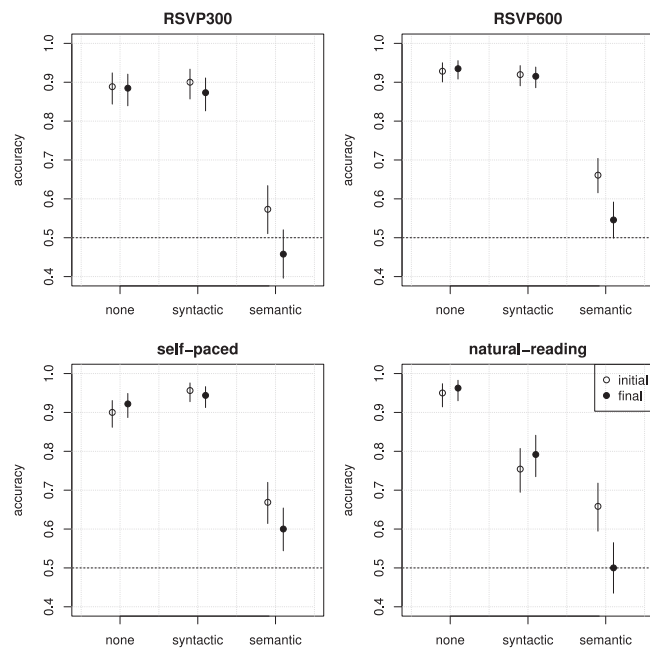
Late syntactic violation:

Der erfahrene   Star spielt das_{NEUT} schwierige $Rolle_{FEM}$.
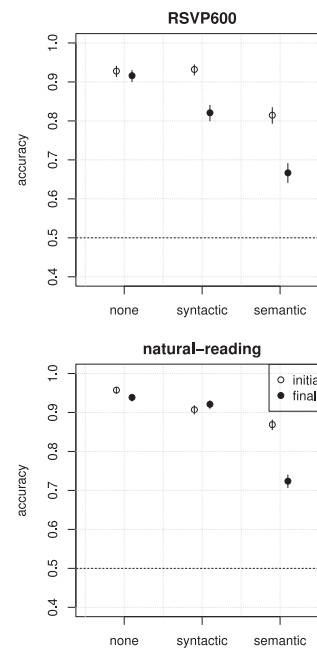The experienced star plays the_{NEUT} difficult $role_{FEM}$.

Late semantic violation:

Der erfahrene   Star spielt die_{FEM} elektrische $Rolle_{FEM}$.
The experienced star plays the_{FEM} electric $role_{FEM}$.

Results:

Results Metzner, Malsburg, Vasishth (CUNY, 2014):

Discussion:

- For syntactic violations, natural reading yielded lower accuracy than the other types of reading, probably due to skipping of the determiner.
- Accuracy for control sentences and sentences with semantic violations differed very little accross modalities.
- Low performance for semantic violations across the board due to vagueness of what qualifies as a semantic violation.
- Results for natural reading markedly different from those obtained in a similar lab-based experiment where natural reading yielded good performance on sentences with syntactic violations (Metzner, von der Malsburg, Vasishth, CUNY, 2014).
- Performance in the lab-based experiment was generally higher than in the online study.

Conclusions:

- Readers adapt reading strategies to the circumstances (cf. Bicknell, Levy, 2010; Lewis, Shvartsman, Singh, 2013).
- Effects of presentation modality and type of reading are not generally orthogonal to linguistic manipulations.
⇒ Presentation modality matters.
⇒ Experiment setting (lab-based or online) does, too.