The brain dissociates between different levels of prediction violation during language comprehension...but not always

During language comprehension, probabilistic predictions are generated at multiple levels of representations [1]. Distinct event-related potentials (ERPs) have been linked to inputs that fulfill or violate predictions at these different levels. The N400 has been linked to the semantic predictability of incoming words [2], regardless of their plausibility [3] or the lexical constraint of their preceding context [4]. An Anterior Late Positivity has been associated with words that violate highly lexically constraining contexts [4], while a Posterior Late Positivity/P600 is often evoked by words that are highly implausible, particularly when they violate the semantic-thematic constraints of their preceding verbs or arguments [5]. This previous ERP research, however, has come from different labs who have usually studied just one or two of these ERP components at a time, often using structurally heterogeneous contexts and different tasks. It is therefore difficult to compare across studies. In two ERP experiments, we aimed to dissociate these neural signatures in the same participants using tightly controlled linguistic stimuli. We separately manipulated the lexical constraint of the context (operationalized by cloze norms), and whether noun-phrase arguments (critical words: CWs) fulfilled or violated these lexical constraints and/or the semantic-thematic restrictions of their preceding verbs (conditions 1-5). CWs in conditions 2-5 had zero cloze probability and were matched on simple semantic relatedness with words in their preceding contexts using Latent Semantic Analysis.

In Experiment 1, the contexts constituted two-sentence discourse scenarios. Contextual constraint was determined purely by these two sentences; the CWs in a third sentence were preceded by non-lexically constraining verbs (independently verified using additional cloze norms). Methods: 24 participants read and judged the acceptability of the five types of discourse scenarios, counterbalanced and randomized across lists. The discourse contexts were presented one sentence at a time, and the final sentences were presented word-by-word. Results: On CWs, the amplitude of the N400 was selectively reduced in condition 1 (lexically expected CWs) compared to all other conditions. The N400 was not modulated either by the plausibility of the CW or the lexical constraint of its preceding context (Fig. 1). An Anterior Late Positivity was selectively enhanced on CWs that violated lexically constraining contexts (Fig. 2), while a Posterior Late Positivity/P600 was selectively enhanced on CWs that violated the semantic-thematic restrictions of their preceding verb (larger following lexically constraining than non-constraining contexts, Fig. 3).

In Experiment 2, the contexts were minimal, with their constraints being determined purely by the lexical properties of a single verb. Their constraints were fully matched to the constraints of the discourse contexts in Experiment 1. Methods: 28 participants read and judged the acceptability of the five types of sentences, again presented word-by-word, counterbalanced and randomized across lists. Results: Again, the N400 was modulated only by the predictability of the CWs (Fig. 4). Unlike in Experiment 1, however, no Late Positivities were elicited, either on CWs that violated the verbs’ fine-grained lexical constraints (Fig. 5) or that violated their semantic-thematic restrictions (Fig. 6).

Conclusion: Our findings underline the fact that the N400 primarily reflects the predictability of an incoming word’s semantic features, rather than either its plausibility or the lexical constraint of its preceding context. The results of Experiment 1 show that words violating high certainty predictions lead to prolonged neural processing, with distinct neurocognitive mechanisms engaged depending on the level of prediction that is violated (lexical versus semantic-thematic predictions). The results of Experiment 2, however, suggest that comprehenders do not necessarily or always engage in this additional neural analysis. We suggest that this depends on whether a particular context provides enough time and/or promotes a rich enough representation for comprehenders to generate specific lexical or semantic-thematic predictions during fast, online comprehension.
**Example stimuli.**

<table>
<thead>
<tr>
<th>Contextual Constraint</th>
<th>CW</th>
<th>Experiment 1 example</th>
<th>CW</th>
<th>Experiment 2 example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly lexically constraining (Mean: 79%)</td>
<td>(1) Lexically expected</td>
<td>The lifeguards received a report of sharks right near the beach. Their immediate concern was to prevent any incidents in the sea. Hence they cautioned the swimmers...</td>
<td>(2) Lexical violation</td>
<td>John evacuated the building...</td>
</tr>
<tr>
<td></td>
<td>(3) Lexical &amp; semantic-thematic violation</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Non-constraining (Mean: 26%)</td>
<td>(4) Lexically unexpected</td>
<td>Eric and Grant received the news late in the day. They mulled over the information, and decided it was better to act sooner rather than later, Hence they cautioned the trainees...</td>
<td>(5) Semantic-thematic violation</td>
<td>John departed the subway...</td>
</tr>
<tr>
<td></td>
<td>(5) Semantic-thematic violation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CW:** critical word

... indicates that sentences continued with 3-5 words until the end of the sentence. Additional fillers were included to equalize the proportion of implausible and plausible sentences and lexically constraining and non-constraining contexts seen by participants.

(1) Lexically expected ——

(2) Lexical violation ——

(3) Lexical & semantic-thematic violation ——

(4) Lexically unexpected ——

(5) Semantic-thematic violation ——

**References**