Research Report

What makes a discourse constraining? Comparing the effects of discourse message and scenario fit on the discourse-dependent N400 effect

Marte Otten[a,*], Jos J.A. Van Berkum[a,b,c]

[a]Department of Psychology, University of Amsterdam, Roetersstraat 15, 1018 WB Amsterdam, The Netherlands
[b]F.C. Donders Centre for Cognitive Neuroimaging, Nijmegen, The Netherlands
[c]Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands

A R T I C L E   I N F O

A B S T R A C T

A discourse context provides a reader with a great deal of information that can provide constraints for further language processing, at several different levels. In this experiment we used event-related potentials (ERPs) to explore whether discourse-generated contextual constraints are based on the precise message of the discourse or, more 'loosely', on the scenario suggested by one or more content words in the text. Participants read constraining stories whose precise message rendered a particular word highly predictable ("The manager thought that the board of directors should assemble to discuss the issue. He planned a… [meeting]") as well as non-constraining control stories that were only biasing in virtue of the scenario suggested by some of the words ("The manager thought that the board of directors need not assemble to discuss the issue. He planned a…"). Coherent words that were inconsistent with the message-level expectation raised in a constraining discourse (e.g., "session" instead of "meeting") elicited a classic centroparietal N400 effect. However, when the same words were only inconsistent with the scenario loosely suggested by earlier words in the text, they elicited a different negativity around 400 ms, with a more anterior, left-lateralized maximum. The fact that the discourse-dependent N400 effect cannot be reduced to scenario-mediated priming reveals that it reflects the rapid use of precise message-level constraints in comprehension. At the same time, the left-lateralized negativity in non-constraining stories suggests that, at least in the absence of strong message-level constraints, scenario-mediated priming does also rapidly affect comprehension.

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1. Introduction

Over the last two decades, event-related potentials (ERPs) have considerably advanced our understanding of the cognitive processes underlying language comprehension. The N400, an ERP component that is particularly sensitive to semantic processing, has played a major role in this. The N400 has been used to study the comprehension of written, spoken and signed language (see Kutas et al. (2006) for review), as well as the breakdown of language or of related cognitive functions in, for example, aphasia (Hagoort et al., 1996; Swaab et al., 1997), schizophrenia (Sitnikova et al., 2002), and Alzheimer's disease (Ford et al., 1996). The N400 component was discovered by Kutas and Hillyard (1980), who found that a sentence-final

word that was incongruent with the preceding linguistic context evoked a larger negativity than a congruent ending. Later experiments showed that the N400 was more than a semantic anomaly detector. In particular, relative to highly expected words, semantically coherent but unexpected words also evoked a larger N400, albeit not as large as anomalies (Kutas and Hillyard, 1984). Based on these and other findings, Kutas and colleagues (2006) have recently argued that the amplitude of the N400 reflects the degree to which "context aids in the interpretation of a potentially meaningful stimulus." In line with this, language researchers generally agree that the word-elicited N400 indexes how well the meaning of a word fits the constraints set by the context (Chwilla et al., 1995; Coulson and Federmeier, in press; Friederici, 1995; Hagoort et al., 2004; Osterhout and Holcomb, 1995; Van Berkum et al., 1999, 2003).

But what are those constraints? Following up on the pioneering N400 research of St. George et al. (1994), ERP experiments with text-level manipulations suggest that the N400 is not only sensitive to constraints provided by a single word prime or an unfolding single sentence, but is also highly sensitive to what the wider discourse is about (Federmeier and Kutas, 1999b; Nieuwland and Van Berkum, 2006; St George et al., 1997; Van Berkum et al., 1999, 2003, 2005). In stories such as (1), for example, the discourse-supported word "movie" elicited a much smaller N400 than the discourse-inappropriate word "book" (Van Berkum et al., 1999, 2003). Such discourse-dependent N400 effects have been interpreted as evidence that the language comprehension system immediately evaluates the current word against a precise message-level representation of what has been said so far.

> (1) *David and Sabrina had been thinking about what they were going to do that evening, and eventually decided to go to the cinema. They hoped the movie/book would be fun, but it turned out to be quite boring.*

However, an important alternative interpretation has as yet not been ruled out. Models of text comprehension and memory suggest that in addition to contributing to a precise message-level representation of the discourse, the words in a text can also provide semantic constraints in a much less precise way, via the activation of related information stored in long-term memory (Kintsch, 1988; McKoon and Ratcliff, 1992; Sanford, 1990). In the above story, for instance, the mere presence of the word "cinema" could activate a going-to-the-movies scenario, which includes seeing a film. The attenuation of the N400 in (1) might thus also come about because the word "movie" is relevant to the scenario suggested by one or several words in the preceding text.

The difference between a message-level and scenario-mediated account for discourse-dependent N400 effects may not be obvious at first. After all, our understanding of what has been said so far, the precise message, will in part depend on our default knowledge about what things tend to go together in the world (as captured in scenarios, scripts, etc.). However, consider what would happen if we change the precise message of the discourse, as in (2). Although the going-to-the-movies-scenario is still implied by the words in the

context, the actual message of the story does not really support either "movie" or "book"

> (2) *David and Sabrina had been thinking about what they were going to do that evening, and eventually decided not to go to the cinema. They hoped the movie/book would be out on dvd soon, and went to the pub.*

In the ERP study reported below, we try to disentangle the effects of message- and scenario-level constraints by exploiting the possibility to change the message of a story while leaving the scenario-relevant words in that story intact. The goal is to examine whether the discourse-dependent N400 effect hinges on constraints provided by the exact message-level representation of the prior text (as assumed in Van Berkum et al., 1999, 2003), or whether it can perhaps be accounted for – entirely or in part – by scenario-mediated lexical priming.

Behavioral experiments have shown that this scenario-mediated priming does play a role in comprehension, and can do so even when the scenario-generated information is irrelevant to, or at odds with, the actual message (Duffy et al., 1989; Garrod and Terras, 2000; O'Seaghdha, 1997). Garrod and Terras (2000), for example, showed that the word "pen" is *initially* just as effectively integrated when presented in a sentence following "The teacher wrote a letter" as it is after the sentence "The teacher wrote the exercise on the black-board". Only in regression path analysis and second pass reading times a significant difference was observed between the appropriate and inappropriate contextual message. This indicates that participants did not at first notice the message-level incongruence of "pen", presumably because "pen" is strongly associated with the default scenario activated by the verb ("to write"). Results like these imply that contextually activated scenarios can prime scenario-related concepts, leading to facilitated processing of these concepts and the words that denote them. Furthermore, they show that scenario-related facilitation is in some cases initially stronger than the support provided by the actual message of the discourse.

To account for such results, models of text comprehension (Kintsch, 1988, 1998; Sanford and Garrod, 1981, 1998) usually include an initial stage in which all potentially relevant information is retrieved in a way that is highly sensitive to the set of words and concepts in the text, regardless of the precise message of the text. For example, the scenario-mapping and focus theory of Sanford and Garrod (1981, 1998) proposes that the word currently read or heard (e.g., "movie") is initially evaluated in terms of a 'quick and dirty' match to prior words in the text and the scenario suggested by those words, before it is mapped more carefully onto the precise message conveyed by that text. Kintsch (1988, 1998) has made similar proposals. The dominant model for the relatively shallow initial retrieval process involved in these accounts is the *resonance model* (Cook et al., 1998; Myers and O' Brien, 1998; Myers et al., 1994). According to this model, individual concepts from the linguistic input send out a signal to long-term memory. Concepts in memory then resonate as a function of their relatedness to the input, based on the overlap between the semantic and contextual features of the concepts involved. Eventually, those concepts that have the highest