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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 28(28)

ISSN

1069-7977

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Publication Date

2006

Peer reviewed

Context and the Processing of Discourse: Priming and Genre Effects on Discourse Comprehension

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Abstract

Many theories of discourse structure rely on the idea that the segments comprising the discourse are linked through inferred relations such as causality and temporal contiguity. These theories suggest that all of the information needed to determine the relation can be found when the discourse is interpreted through the application of world knowledge. However, Sanders (1997) found that the interpretation of ambiguous relations can be affected by the discourse's genre. Two experiments examine whether these genre effects are mediated through a cognitive process sensitive to non-linguistic information. Experiment 1 shows that discourse relations are affected by repetition priming effects, while Experiment 2 suggests that the processing of discourse relations is sensitive to the expected frequency of the relations as exhibited in the text.

Keywords: Discourse, Discourse Relations, Genre, Priming

Introduction

Linguistic theories of discourse comprehension often propose that local coherence within a discourse is established through the use of *discourse relations*¹ (e.g. Asher & Lascarides, 2003; Hobbs, 1979; Kehler, 2002; Mann and Thompson, 1988; Polnaya, van Den Berg & Ahn, 2003; Sanders, Spooren & Noordman, 1992). Most of these theories are based on the segmentation of a discourse into a set of segments (often sentences or phrases) which are then bound together by discourse relations into a coherent unit.

For example, consider the discourse (1):

- (1) a. John is a good chess player.
b. He always beats James.

The two sentences form a complete discourse made up of two discourse units. One way to bind the two discourse fragments together would be to assume that sentence (1b) is a justification for the claim made in (1a). By Asher and Lascarides (2003)'s terminology the appropriate relation in this case is *elaboration*².

In addition to listing the possible relations and their properties, some theories also suggest algorithmic processes

that may be employed to determine the appropriate relations, given a sufficiently detailed account of the discourse. For instance, Hobbs (1993) suggests that the process of abduction can be used to determine the appropriateness of candidate relations. Similarly, Asher & Lascarides (2003) suggest each discourse relation imposes a set of constraints on the discourse and that it is possible to infer the appropriate relation by testing these conditions.

A similar notion of discourse structure arises from some cognitive theories of discourse comprehension (van Dijk & Kintsch, 1983; Kintsch, 1998). In congruence with most linguistic theories, van Dijk and Kintsch suggest that the discourse is structured hierarchically, and that each level in the hierarchy acts as a summary of the content of the original discourse. However, their account of the relations between discourse segments is based on bridging inferences rather than on a catalogue of specific discourse relations³.

While most theories of discourse structure focus on the content and of the discourse as the source for discourse relations it seems reasonable that other factors might influence the specifics of the relation chosen by a comprehender. For instance, Sanders (1997) conducted an experiment to examine whether people are sensitive to the *source of coherence*⁴ distinction outlined in an earlier work (Sanders et al., 1992). He presented expert discourse analysts with discourses that included "chameleon" causal relations, whose source of coherence could be either semantic or pragmatic. These sentences were embedded in one of two possible genres – an argumentative version of the text or a descriptive version. While participants found both interpretations on the relation equally likely in the argumentative version, most participants agreed that in the descriptive version the source of coherence was most likely semantic. Sanders also presented an analysis of discourses of genres similar to those in the two versions. His analysis suggested that the interpretations his participants arrived at mirrored the distribution of relation types in the genre.

If we assume that Sanders' interpretation of his results is correct a new question arises – What is the mechanism (or mechanisms) through which a discourse's genre affects the interpretation of ambiguous relations within it?

¹ While this paper will use the term *discourse relations*, other names have also been used in the literature for very similar concepts. These include *coherence relations* (Kehler, 2002) and *rhetorical relations* (Mann and Thompson, 1986).

² For the sake of consistency, this paper will adhere to names and definitions of discourse relations as presented in Asher and Lascarides (2003). It should be noted that while the labels used by theories for relations differ, it is often difficult to find specific relations that different theories would categorize differently.

³ van Dijk and Kintsch's hierarchy is based on three distinct hierarchy-forming processes, but those transform the discourse propositions, rather than semantically constrain or enhance them as discourse relations do.

⁴ "Source of Coherence" is one of four primitives Sanders et al. (1992) suggest as the basis for a possible classification system of coherence relations (e.g., *Cause-Consequence* vs. *Argument-Claim*).

One possible explanation is that discourse comprehension is directly affected by the perceived genre of the discourse (e.g. Kintsch's *textual schema*). This account implies that people differentiate among discourse genres and that such genres are discrete and identifiable types. While this is an attractive notion, there might be situations in which several different genres could be applicable. Furthermore, in some cases a novel genre might be encountered, or even expected. Moreover, it is likely that readers can construct models for new genres as they encounter them (e.g. an undergraduate encountering a research paper for the first time). Therefore such a top-down notion of genre is probably insufficient as a full description of the effects genre might have on the analysis of a discourse.

A related explanation that does not rely on an explicit, top-down, notion of genre is that ambiguous discourse relations are interpreted based on a set of expectations. These expectations can be affected by many different cognitive processes – including some abstract awareness of genre. However, awareness of genre is not strictly required. Instead, a statistical approach may be employed. Initially, a default set of expectations may be used. These expectations are then adjusted with each discourse relation computed to reflect the general frequency of relations within a discourse. Given enough relations, this method will tend to disambiguate ambiguous relations based on a probabilistic model that matches the genre to which the discourse belongs without requiring awareness of the genre itself – or even of its existence. While awareness of genre is not required, this account is still based on the composition of the discourse as a whole. The set of expectations used to disambiguate discourse relations would therefore gradually adapt to fit the discourse as more of it is read and comprehended.

In contrast, it is also possible that the effects observed by Sanders' originate locally – without attending to the structure or frequencies of relations in the discourse as a whole. Whereas the process described above employs information gathered from the entire discourse, a local account focuses on discourse relations that directly precede the segment in question. Such an account could, for example, be based on direct replication – if a specific discourse relation is underspecified, it may be possible to use information from the previous relation in order to be able to better compute the relation. This may be extended to nearby relations, depending on the process(es) involved.

While the mechanisms of expectations and priming do not rely on an explicit concept of genre they are still able to predict the results described by Sanders (1997). Furthermore, while genre might not be explicitly used by these mechanisms it is still an underlying factor in their facilitating effect. For instance, it is very likely that the frequency distribution of discourse relations differs between different genres.

The present experiments explore whether these two mechanisms might take part in the process of discourse comprehension. Experiment 1 investigates the possibility that the processing of discourse relations is affected by short-term, local, effects. Experiment 2 examines what happens when participants frequently encounter a discourse relation in a genre in which that relation is rarely used.

Experiment 1

One possible explanation for the results described by Sanders is that in addition to the content of the discourse segments and the current representation of the discourse, the process of computing discourse relations also takes into account the results of recent discourse relations computations. In cases where the previous discourse relation computed is similar to the one being computed this may lead to greater efficiency in the computation. Essentially, the computation of a discourse relation might generate an expectation that the same relation will be used again, resulting in a repetition priming effect. Such effects are not unlike those that have been demonstrated for syntactic structures (cf. Bock & Levelt, 1994; Smith & Wheeldon, 2001). Experiment 1 explores this possibility.

Such effects require that the inferences used to identify a specific discourse relation bear some similarity to one another. As such, these inferences should be more than just generalized bridging inferences as suggested by Kintsch (2003). Rather, these inferences must include an explicit reference to the type of relation involved (e.g. Parallel or Elaboration).

Table 1: Sample Stimuli from Experiment 1

Relation	Sentence pair
Parallel	1: Julia is a respected chess player. 2: She excels at poker.
Elaboration	1: Julia is a respected chess player. 2: She has an analytical mind.

Table 2: Sample Question from Experiment 1

How many chess tournaments do you think Julia won?
1. None.
2. A few.
3. More than a few.
4. Many.

Participants were presented with pairs of sentences, one pair at a time. These pairs were related through either a *parallel* relation or an *elaboration* relation (see Table 1 for sample stimuli). In cases where the two sentences were connected through a parallel relation, the propositional content of the second sentence mirrored that of the first sentence but with a different object (e.g., “chess” and “poker”). A sentence pair exhibited an elaboration relation when the second sentence was used to provide evidence for the truthfulness of the first sentence. In both cases the sentence pairs described properties of individuals and no relationship existed between the various sentence pairs.

In order to motivate participants to attend to the meaning of the sentences and to the discourse relations that relate them, participants were later asked to answer questions about the people described in the sentences (see Table 2 for

a sample question)⁵. Four such questions followed each set of 4 sentence pairs – one question per pair. Importantly, because these questions were presented following the presentation of four unrelated sentence pairs it is unlikely that participants would delay the comprehension of the sentence pairs until the relevant question was presented.

A presented sentence pair was considered *primed* if the pair immediately preceding it was of the same type (e.g. a pair exhibiting a parallel discourse relation following a pair exhibiting the same relation). If discourse relations are affected by repetition priming then participants should read stimuli pairs faster when they are preceded by a pair of the same type than when they are preceded by a pair of the other type.

Methods

Participants Forty-two undergraduate students enrolled at Northwestern University participated in this experiment in partial fulfillment of course requirements.

Procedure Participants were asked to read pairs of sentences as quickly as possible but to make sure they have read the sentences carefully as they would be asked questions about the content of the sentences. Sentence pairs were presented on a computer screen, one pair at a time. After reading a pair, participants pressed the spacebar in order to proceed to the next pair, at which time the sentence pair disappear. A second later, a new sentence pair appeared. Reading time was measured as the duration between the onset of presentation of a sentence pair and the time the participant pressed the spacebar.

Over the course of the experiment, each participant was presented with 32 sentence pairs, half of which exhibited a parallel relation and half of which exhibited an elaboration relation. Every fourth sentence pair was followed by a set of four multiple choice questions. After participants answered the four questions they were asked to press the spacebar when they were ready to read the next sentence pair.

The sentence pairs presented to the participants were constructed out of sets containing two possible first sentences and two possible second sentences (see the materials section below). The composition of the sentence pairs, the order of their presentation, and whether they were primed or not was counterbalanced across participants.

Materials The experimental stimuli consisted of 16 sets of 4 sentences. Each set included two “head” sentences and two “tail” sentences. An experimental sentence pair was constructed by joining together a head sentence with a tail sentence. There two head sentences were analogous to one another, while the two tail sentences were related to the head sentences through either a parallel or an elaboration discourse relation (see Table 3 for an example of such a complete set). In this way, all participants were presented

⁵ It should be noted that if participants did not attend to the sentence and did not draw any inferences about them, then no priming effect should be expected.

with the same sentences and therefore each participant was exposed to exactly the same words and propositions. However each head sentence participated in a parallel discourse relation for half the participants, and an elaboration relation for the other half of the participants. In addition, a question was designed for each head sentence.

Table 3: Sample Stimuli Set from Experiment 1

Type	Sentence pair
Head 1	Stacy wears a ring on her index finger.
Head 2	Traci keeps a ruby pendant on her desk.
Parallel	She owns a Rolex watch.
Elaboration	She appreciates jewelry.

Results

In order to better control for the variability in sentence length, reading times for the sentence pairs were divided by the number of words in the sentence pair⁶. Furthermore, only sentence pairs preceded by a sentence pair were included in the analyzed data⁷. Additionally, an initial analysis of the distribution of the reading times showed a significant positive skew of the distribution, as is often the case with reading times. In order to normalize the distribution, outliers were removed according to the method described by Tukey (1977). Tukey defined outliers as values that lie further than 1.5 times the inter-quartile range from the appropriate inter-quartile percentile (below Q1 or above Q3). The determination of outliers was performed separately for each discourse relation type. This excluded 3.6% of the data from the analysis.

The overall mean of reading times for each of the four conditions is given in Table 4. Table 4 also shows the difference between the primed and unprimed means as the priming index. The means of the four conditions were calculated for each participant, and a repeated-measures ANOVA was performed on the resulting data. This ANOVA used the relation type of the sentence pair and the relation type of the preceding sentence pair as within-participant variables. There was a significant main effect for the type of the discourse relation (sentence pairs exhibiting a parallel relation took longer to read than pairs exhibiting an explanation relation) ($F(1,41) = 8.08; p < .01$), and a significant interaction between the type of relation exhibited by the sentence pair and the type of relation exhibited by the previous pair ($F(1,41) = 9.81; p < .01$). There was no significant main effect for the type of discourse relation of the previous sentence pair ($F(1,41) = .66; p > .1$).

⁶ This is meant to make the sentence reading times roughly comparable. However, since the comparison here is between the reading times of the same sentences in either a primed position or an unprimed position, normalization is not strictly required for the purposes of the analysis.

⁷ This excluded the first sentence pair of each block – these sentences tended to exhibit a significantly higher reading time, presumably because they represented the start of a new “discourse”

An item analysis, using the same repeated measures ANOVA used for the participant analysis yielded non-significant main effects (for the discourse relation: $F(1,23) = 2.91$; $p > .1$; for the previous discourse relation: $F(1,23) = .155$; $p > .1$) and a marginally significant interaction ($F(1,23) = 3.88$; $p = .06$). While the item analysis revealed no significant interaction, this is possibly because more items are required for a significant effect due to the relatively small effect size.

The interaction between the discourse relation of the previous sentence pair and the discourse relation of the current sentence pair represents the hypothesized priming effect – If the two discourse relations match the sentence pair is read faster than if the two discourse relations do not match. To further explore this effect, two planned comparisons were performed. These yielded a significant difference for elaboration relations ($t(41) = 2.70$; $p < .01$, one-tailed), but only a marginally-significant difference for parallel relations ($t(41) = 1.52$; $p = .07$, one-tailed).

Table 4: Mean Word Reading Time for the current sentence pair by Condition (ms).

		Previous relation		Priming index
		Parallel	Elaboration	
Current relation	Parallel	303	320	17
	Elaboration	301	288	23

Discussion

Experiment 1 demonstrates that the processing of discourse relations does exhibit repetition priming effects. In turn, this lends support to the hypothesis that local effects might play a role in genre effects on the processing of discourse, such as those reported by Sanders (1997).

Furthermore, such effects are not predicted by models proposing that discourse relations are determined through a fixed process that is only affected by the semantic content of the discourse segments and the context of the discourse, such as the one described by Asher and Lascarides (2003). In contrast, the abduction model proposed by Hobbs et al. (1993) may account for this result by assuming that the weights used in the computation are continually adjusted.

This result also suggests that the inferences drawn by readers are differentiated based on the type of discourse relations. It is unlikely that the observed priming effect can occur between two generalized inferences that are based on the specifics of the discourse in question. Instead, it is more likely that a generalizing principle, such as the type of discourse relation, is extracted. This provides support for theories arguing that discourse structure is based on a specific catalogue of discourse relations (e.g. Asher & Lascarides, 2003; Mann and Thompson, 1988).

Nevertheless, even if local priming effects may be able to account for the Sanders' results, it may still be the case that a less localized process might also play a role in the interactions between genre and discourse relations. More specifically, if we assume that the priming effects observed

in experiment 1 are a result of shifts in the way the cognitive process responsible for the determination of discourse relations works then it is possible that under some cases such shifts may be cumulative and result in a gradual shift in processing expectations as to the structure of the discourse. Experiment 2 examines a case in which such a gradual shift may be evident.

Experiment 2

While experiment 1 demonstrated how a single instance of a discourse relation can affect the processing of discourse, experiment 2 attempts to create a situation that is closer to that to which participants in Sanders' experiment were exposed to. The short, isolated discourses embodied by the two-sentence lines of experiment 1 are replaced by a more continuous narrative intended to produce a sense of genre.

However, while the genre employed in this experiment might be broadly construed as a narrative, it is an overly simplified narrative genre employing only two discourse relations. The first relation used in experiment 2 is *narration*. This relation is common and straightforward, it relates to discourse segments through temporal continuity in which the second segment follows the first one temporally, while maintaining the same context.

The second discourse relation used in this experiment has been named *background* by Asher and Lascarides. In many ways, this relation is the inverse of the narration relation. Instead of providing information as to "what happens after", the background relation provides background information that pertains to the action described. Frequently, this is information about a state that was in effect when the action started, or even a prerequisite for the action. Table 5 presents a sample sentence pair for each of the two types.

While the relation is employed in the narrative genre, it is much less frequent than the use of narration and other relations that imply an advancing temporal flow. In a sense, the notion of a narrative as telling a story relies on the general tendency of its constituents to portray a sequence of events in the same order in which those events occurred. The background relation impedes and might even reverses this flow, resulting in the a somewhat stunted narrative.

Table 5: Sample Stimuli from Experiment 2

Relation	Sentence pair
Narration	1: John dismantled a Lego spaceship.
	2: It took him 5 minutes to rebuild it.
Background	1: John dismantled a Lego spaceship.
	2: It took him 5 minutes to build it.

Experiment 2 relies on this scarcity of background relations within the genre of narrative to examine how participants' expectations of a discourse shape their comprehension of it. Participants are presented with miniature stories – narratives, in essence. But those narratives include a disproportionate number of background relations. If participants' expectations of the genre affect their processing of discourse, then the frequency of

background relations should contradict their initial expectations and slow their processing initially.

However, as their experience with the new genre grows, their expectations might undergo a change – They might learn that in this new genre background discourse relations are frequent and normative and therefore come to expect them. This may then result in increased efficiency in the processing of such relations, and the discourse as a whole.

Methods

Participants Twenty-three undergraduate students enrolled at Northwestern University participated in this experiment in partial fulfillment of course requirements.

Procedure The procedure of this study is similar to that used in experiment 1. Participants were asked to carefully read pairs of sentences as quickly as possible. These sentence pairs were presented on a computer screen, one pair at a time. After reading a pair, participants pressed the spacebar in order to proceed to the next pair, at which time the sentence pair disappears. A second later, a new sentence pair appeared. Reading time was measured as the duration between the presentation of a sentence pair on the screen and the time the participant pressed the spacebar.

Following each narrative, participants were asked to answer three multiple choice questions regarding their impressions of the child's behavior. These questions were the same for all the narratives.

There were two versions of each sentence pair, and the presented version was counterbalanced across participants. Furthermore, the order in which the narratives were presented was also counterbalanced across participants.

Materials The experimental stimuli consisted of 8 narratives. Each narrative was made up of 4 sentence pairs, and there were two versions of each sentence pair. Sentence pairs belonging to the same narrative shared a single actor, who was described as a child playing in a psychology lab. In one version the two sentences were related through a narration relation, while in the second the two sentences were related through a background relation. The difference between the versions was in the verb used to describe the protagonist's action in the second sentence.

Results

In order to better control for the variability in sentence length, reading times for the sentence pairs were divided by the number of words in the sentence pair.

Figure 1 tracks the mean reading times for each type of discourse relation as it changes across the course of the experiment. A regression model was used in order to test the hypothesis that participants improved more in their processing of background discourse relations than in their processing of narration relations. The regression model tested for an interaction between the ordinal position of a sentence pair within the experiment and its type while controlling for both the participant and the particular

sentence pair involved. The model was statistically significant ($F(56, 679) = 8.54; p < .01; R^2 = .41$). There was a statistically significant interaction between type and ordinal position ($F(1, 679) = 7.46; p < 0.01$) as well as main effects for both ordinal position ($F(1, 679) = 45.72; p < .01$) and type of relation ($F(1, 679) = 21.75; p < .01$).

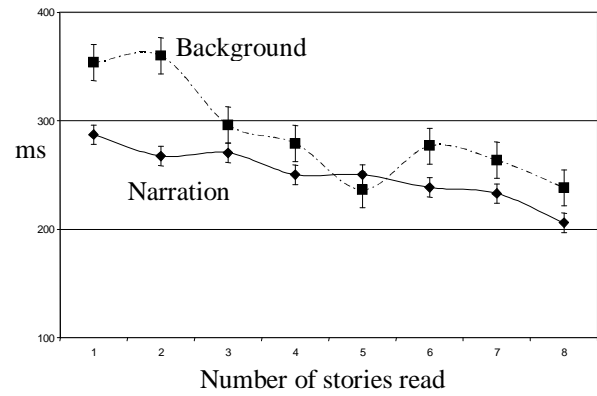


Figure 1: Mean Word Reading Time (in milliseconds) by Type and Stories Read

Discussion

As predicted, participants in experiment 2 started out processing background discourse relations fairly slowly. Participants also showed dramatic improvement in their processing of those relations across the experiment. It can therefore be argued that the cognitive process underlying the calculation of discourse relations is sensitive not only to local, priming, effects, but also to the general frequency of particular relations within the discourse.

Participants seem to be able to adjust their comprehension strategies to accommodate new and unexpected discourse schemas. This suggests that the processes underlying sensitivity to genre as demonstrated by Sanders (1997) are unlikely to *require* some overt notion of genre and are able to adapt to a variety of discourse genres, even when such genres are not explicitly defined. More generally, it appears that the processing of discourse relations is affected by previously computed relations, perhaps through a set of implicit expectations about the structure of discourse.

General Discussion

This paper presented evidence that the people's processing of discourse relations is sensitive not only to the content of the discourse, but also to the type and frequency of previously determined discourse relations. Because these factors are not strictly a part of the discourse, it seems that the inference of discourse relations and structures takes into account more than just the propositions of the discourse and relevant world knowledge. Rather, the more general context in which the discourse is encountered (e.g., what genres the reader is versed in) plays a role as well.

Furthermore, these results might also affect theories that are not directly concerned with cognitive processes, but

rather with the structure and representation of discourse. As mentioned above, Sanders (1997) demonstrated that the genre to which a discourse belongs affects participants' perception of ambiguous discourse relations within it. However, if the processing of discourse is affected by factors such as priming and expectations, then it is likely that the very interpretation of such relations, to the extent that they are underdetermined, can also be affected. These processes might therefore have some measure of influence on the meaning people extract out of discourse relations.

Consequently, it is possible that the meaning of a discourse is not strictly determined by its content. Instead, these cognitive effects suggest that a discourse may only have a determinate meaning within the scope of a specific comprehension episode. This imposes limits on the completeness of representation that can be achieved through the analysis of a discourse in a context-less manner (e.g., without relating it to a specific comprehension episode). It is therefore important that theories of discourse structure and meaning allow for some indeterminacy as part of their analysis. Indeed, some theories have already incorporated mechanisms that allow discourse representations to be underdetermined (e.g. Asher & Lascarides, 2003).

More generally, the comprehension of discourse is a cognitive process and as such can be influenced by factors other than those internal to the linguistic structure. Theories of discourse comprehension, including those focused on discourse structure and relations, must take the cognitive underpinnings of the process into account.

Additionally, the results described in this paper suggest that the distinction between various discourse relations drawn by many theories of discourse structure is mirrored by the cognitive processes in charge of discourse comprehension. As such, it seems unlikely that simple bridging inferences are the result of such processes as suggested by Kintsch (2003). Instead, it is likely that specific inferences are drawn in order to bind the segments into a coherent discourse. These are probably based on distinct relations such as *elaboration* and *narration*.

Moreover, if discourse relations have cognitive properties, new questions arise. One such question pertains to the nature of discourse relations: Most theories assume that these relations are atomic concepts that index some logical function. Some even suggest that discourse relations are lexicalized (Knott, 1995). But is that necessarily so? Sanders et al. (1992) argues that it is possible to classify discourse relations using a small set of defining primitives. If that is so, perhaps a discourse relation is nothing more than a collection of primitives?

It is interesting to note that these cross-discourse effects also suggest that discourse relations are inferred as part of the comprehension process. This result provides support for the hypothesis that discourse inferences are necessarily drawn during comprehension as has often been suggested in the literature (cf. van Dijk & Kintsch, 1983, pp. 49-51).

Finally, both Asher and Lascarides (2003) and Sanders et al. (1992) argue that the set of discourse relations should be

considered as a closed set – that discourse relations are essentially primitives and that new ones cannot be learned. However, as demonstrated by experiment 2, the ease with which relations are comprehended can vary with experience with the relation and the genre. While it is possible to account for this result strictly through the use of differences in expectations and processing, it is also possible to interpret this result as indicating that some mechanism of learning plays a part in the processing of discourse relations. If that is the case, it is entirely possible that new discourse relations can be learned. While the evidence presented within this paper cannot resolve this issue, it suggests an approach that may be able to shed a new light on it.

Acknowledgments

I would like to thank Lance Rips and the members of the Rips lab for their help in designing the experiments and for their useful comments regarding the analysis of the results.

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