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Coherence Marking, Prior Knowledge, and Comprehension of Informative and Persuasive Texts: Sorting Things Out

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Coherence plays a central role when readers construct meaning from a text. Previous research has shown how coherence marking affects text processing and representation. However, this effect seems to depend on reader's prior knowledge of the text content: Low knowledge readers benefit from coherence marking, whereas high knowledge readers benefit from a more implicit text (McNamara & Kintsch, 1996). Because this interaction was not consistently found in previous research, this article takes a closer look at the operationalization of the experimental variables: coherence marking, prior knowledge, and text comprehension. Also, this article compares the effect on both informative and persuasive texts. Results indicate that linguistic marking of coherence indeed interacts with prior knowledge in the informative genre, but not in the persuasive genre.

Understanding discourse means that readers construct a mental representation of the information in the text. A successful mental representation is a coherent one, where representations of the segments in the discourse are linked to one another (cf. Hobbs 1979; Sanders, Spooren, & Noordman 1992). These so-called *coherence relations* are commonly regarded as "the cornerstone of comprehension" (Graesser, McNamara, & Louwerse, 2003, p. 82). Coherence relations are meaning relations that connect discourse segments and are minimally clauses. Examples are relations such as "cause–consequence," "list," and "problem–solution."

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COHERENCE MARKING AND MEANING CONSTRUCTION

Coherence relations are fundamentally conceptual, but they can be made explicit by linguistic markers. These markers include connectives (*because, so, however, although*) and lexical cue phrases (*for that reason, as a result, on the other hand*). A central objective of cognitive scientists working on discourse, including linguistics and psychology alike, is to characterize the nature of the connectedness that makes a set of utterances *bona fide* discourse. In this endeavor, the terms *cohesion* and *coherence* have been used (Sanders & Pander Maat, 2006). Linguists have traditionally approached this problem by looking at overt linguistic elements and structures. Ever since Halliday and Hasan's (1976) *Cohesion in English,* the term *cohesion* is used for this approach (see Graesser et al., 2003). Over the last 2 decades, the dominant view has come to be that the connectedness of discourse is a characteristic of the mental representation of the text rather than of the text itself. The connectedness thus conceived is called *coherence*. Language users establish coherence by relating the different information units in the text.

Although we investigate the effect of explicit textual cues on readers' mental representations in this article, we do so from the point of view of coherence rather than one of cohesion—that is, we consider connectives and lexical cue phrases as processing instructions for the reader to infer the coherence relation between segments. This linguistic coherence marking can help readers in constructing these coherence relations. These markers explicitly guide the reader in interpreting the text and in connecting ideas with other ideas (Britton, 1994; Noordman & Vonk, 1997; Sanders & Noordman, 2000) and can, therefore, play an important role when readers construct meaning from discourse. For that reason, we use the term *coherence markers* to refer to these linguistic signals.

Coherence Marking and Prior Knowledge

In general, the effect of coherence marking on the mental representation after reading a text is not clear-cut (for a recent overview, see Sanders & Spooren, 2006). On the one hand, there has been research that showed that markers of coherence cause better answers on text comprehension questions (Degand, Lefevre, & Bestgen, 1999; Degand & Sanders, 2002). On the other hand, some researchers have not found any effect of coherence marking on text comprehension questions (Spyridakis & Standal, 1987). Furthermore, markers of coherence do not seem to influence the quantity of remembered information (Britton, Glynn, Meyer, & Penland, 1982; Sanders & Noordman, 2000), but they do influence the quality of remembered information (Meyer, Brandt, & Bluth, 1980). Not all of these studies were equally reliable (see Degand & Sanders,

2002). The studies varied in the quality of the manipulations, naturalness, length of the experimental texts, and (last but not least) the characteristics of the readers; but these attributes were not consistently specified in the research. In the experiments reported in this article, we used natural texts of a considerable length, and we included a very important reader characteristic: prior knowledge about the text topic.

Coherence marking has often been examined in combination with prior knowledge. Roller (1990) suggested an interaction between text structure and prior knowledge, in the sense that text structure helps the reader when the topic of a text is unfamiliar; but when the topic is familiar, the relations are already known to the reader. However, even when the reader's prior knowledge was included in experimental research on coherence marking, the results were conflicting. Some researchers have reported an interaction between the linguistic marking of text structure and prior knowledge (McNamara, Kintsch, Songer, & Kintsch, 1996; McNamara & Kintsch, 1996): Readers with more prior knowledge optimally benefited from a non-marked or implicit text, whereas readers with less prior knowledge performed better on text comprehension questions after a marked or explicit text. This interaction effect was replicated by McNamara (2001) and Voss and Ney Silfies (1996).

Other studies did not show such an interaction between prior knowledge and coherence marking. An example is the study by Boscolo and Mason (2003), who hypothesized the same interaction reported by McNamara and Kintsch (1996). They reported both a main effect of coherence marking and a main effect of prior knowledge, but no interaction. McKeown, Beck, Sinatra, and Loxterman (1992) showed a main effect of coherence marking, but again no interaction with prior knowledge. In their experiment, students who read the explicit text version had significant advantage in comprehension. The background knowledge students had received did not compensate for the lack of coherence in the original text version. Gilabert, Martínez, and Vidal-Abarca (2005) obtained comparable results: Their explicit text versions benefited low and high knowledge readers. Again, no interaction with prior knowledge was observed.

In sum, a number of researchers have reported an interaction between the text factor coherence marking and the reader characteristic prior knowledge. The presented overview of findings shows that this is not a consistent finding: The nature of the interactions was not consistent, and some researchers only reported main effects.

Operationalizations of Text Comprehension, Coherence Marking, and Prior Knowledge

One of the problems when comparing the results of studies investigating the interaction between coherence marking and prior knowledge was illustrated by

Boscolo and Mason (2003). In their study, different conclusions emerged from different methodologies of assessing text comprehension, such as schematic questions and open questions. Different measurements of text comprehension form a first inconsistent factor within all the studies that we mentioned earlier. The methodology varied from traditional methods such as multiple-choice questions, open-ended questions, and recall tasks to more recently developed tasks such as sorting tasks and tasks that tap the fidelity of mental models.

A second source of variation concerns the way in which coherence markers were varied across several experiments (Degand & Sanders, 2002). Even in the seminal work of McNamara and Kintsch (1996), many different textual aspects were varied at the same time: adding elaborative information, identification of anaphoric references, and even supplying background information (*ARVN* vs. South Vietnamese Army). We believe it is of great importance to investigate the interaction between coherence marking and prior knowledge found by McNamara and Kintsch, but to do so with experimental texts that differ only in linguistic markers of coherence.

A third inconsistency in these studies concerns the operationalization of prior knowledge. Some studies only *assessed* prior knowledge without manipulating it (Boscolo & Mason, 2003; Langer, 1984; McNamara, 2001; McNamara et al., 1996; Voss & Ney Silfies, 1996). On the basis of the results on the prior knowledge assessment, participants were divided into groups (e.g., low prior knowledge and high prior knowledge). Other studies made use of a so-called *expert–novice paradigm*; two groups of participants were chosen that were expected to differ with respect to their level of prior knowledge. An example is the study by Birkmire (1985). She selected physics and music students who read a text on laser technique. The physics students were expected to have more prior knowledge than the music students. Other studies *provided* the necessary prior knowledge to one half of the participants, whereas the other half did not receive such training. Thus, the experimenters created within the experiment a group with and a group without prior knowledge. The specific ways of instructing the participants varied from an instruction booklet (McNamara & Kintsch, 1996) to highly interactive lessons taking from 30 to 60 min (Gilabert et al., 2005; McKeown et al., 1992). By providing prior knowledge, researchers should not present the information from the text, but introduce major events and concepts needed to construct a representation (McKeown et al., 1992). Finally, a last option is to vary the materials (Blanc & Tapiero, 2001). By choosing a text with familiar content, all participants were part of the high prior knowledge group. By choosing a text that was highly unfamiliar, readers did no longer possess the necessary prior knowledge and became the low prior knowledge group for this text.

We can conclude from this overview that there is certainly much methodological variation between studies, both with respect to assessment of text

comprehension as with respect to the operationalization of prior knowledge. In the following experiments, we investigate different operationalizations of both text comprehension and prior knowledge, combined with a third variable: namely, text genre.

Genre

Most of the studies investigating the interaction between coherence marking and prior knowledge made use of informative texts. Some studies focused on narratives. In the experiments reported here, we included text genre systematically as a variable to answer the question of whether the potential interaction between coherence marking and prior knowledge can be generalized over text genre. Two text genres were included: informative and persuasive texts.

The most commonly used definition of persuasive texts based the distinction on the author's intention (e.g., O'Keefe, 1990). A text is persuasive when the author's intent is to change the reader's attitude or behavior. However, that intent is not always clearly visible. A textual characteristic is needed as a criterion for our categorization. Both text structure and text content are characteristics that can make the distinction between text types clearer.

Sanders (1997) showed a clear link between text type and type of coherence relations. He concluded from a corpus study that the text structure of informative texts was dominated by semantic (objective) relations, meaning that discourse segments were mainly related because of their propositional content. By contrast, the structure of persuasive texts was dominated by pragmatic (subjective) relations because the author used more argumentative relations like "claim–argument" and "conclusion." This correlation between text type and relation type shows a crucial characteristic of persuasive text, which can be used for the definition of the genre. This finding was corroborated in a corpus study by Schellens and de Jong (2004), who showed that one characteristic is always present in persuasive communication: pragmatic argumentation. This type of argumentation typically stresses advantages to the desired behavior or disadvantages to the non-desired behavior. The following text passage is illustrative of pragmatic argumentation:

> If you take enough exercise, your muscles, lungs, heart and arteries are used to working. And that feels a lot better. You feel fitter and more energetic—energetic enough to do lots of enjoyable things, for example. (Schellens & de Jong, 2004, p. 304)

This text passage focused on the positive effects of the desired behavior. In our view, pragmatic argumentation is central to the opposition between informative and persuasive texts. Pragmatic argumentation is used in the persuasive texts to

change the reader's attitude or behavior. Consequences are presented as desirable or undesirable. The same consequences can be presented in informative text, but without focusing on why these effects are so desirable or undesirable for the reader.

Goal of the Experiments

The studies reported in this article investigate the interaction between prior knowledge, coherence marking, and genre. Taking the interaction reported by McNamara et al. (1996) as a starting point, we attempted to clarify inconsistencies in previous research by examining different methods to assess text comprehension and to manipulate prior knowledge. We also improved the precise way to create experimental texts in which coherence is marked versus unmarked. To do so, we used experimental texts that differed only in the linguistic coherence marking: In the explicit versions, coherence was marked by connectives and cue phrases, whereas coherence was not marked in the implicit version. Our main goal was to investigate the relation between coherence marking, genre, and prior knowledge.

EXPERIMENT 1

Experiment 1 investigated the effects of linguistic coherence marking and prior knowledge on text comprehension in both the informative and the persuasive genre. We expected to replicate the interaction effect of McNamara and Kintsch (1996) and McNamara et al. (1996): High knowledge readers perform better on text comprehension questions after reading an implicit text than after reading an explicit text. Low knowledge readers perform better after reading an explicit text than after reading an implicit text.

Method

Materials. Two text topics were selected to make natural informative and persuasive texts: genetic manipulation and organ donation. For each topic, we constructed an informative and a persuasive version, based on existing materials in leaflets and public information brochures. Pragmatic argumentation was a central characteristic for the persuasive versions. The persuasive versions underlined the advantages to the desired behavior ("By giving up your organs after death, you are helping other people. This is very important"), or the disadvantages to the undesired behavior ("Eating genetically manipulated food can make you very sick"). The informative texts did not contain pragmatic argumentation, but provided information about the possible consequences from a neutral point of

view. The same consequences were present in both genres, but in the persuasive context, they were evaluated in a negative or positive way and led to a specific type of behavior. In the Appendix, a passage from both the informative and the persuasive genetic manipulation text are represented.

The four experimental texts (informative and persuasive for both topics) were subsequently manipulated to create an implicit and an explicit version. The texts were, on average, two pages long, with approximately 25 manipulations of coherence marking per text. Marking of coherence was taken in a very broad sense in this study. The manipulated coherence markers had in common that they all explicitly marked a relation that otherwise would have to be inferred by the reader. In the following paragraph, we give examples from the organ donation text. In the Appendix, examples from the genetic manipulation text are presented.

The first category of coherence marking is that of global coherence. We manipulated both headings and organizers. An example of a heading would be, "Why should you be an organ donor?," in the explicit version, indicating that this paragraph will provide reasons. In the implicit version, there was no heading. An example of an organizer would be, "There are two types of donation, organ donation and tissue donation," indicating that in the following section, these two different types will be explained. Again, in the implicit version, there was no organizer present.

The second category of coherence markers concerned local coherence relations, manipulated by means of connectives ("*Because* there are not enough organs available, there are long waiting lists and people might die") and lexical cue phrases ("Your permission for donating your organs is centrally registered. *For that reason,* you don't need to carry your codicil around anymore"). In the implicit versions, the connectives and lexical cue phrases were replaced by a full stop.

The third category of coherence that we marked is referential coherence. In the explicit version, we repeated the antecedent, whereas in the implicit version, we used *he, she, it,* or *they.*

To measure text comprehension, four bridging inference questions were constructed for each text. The following passage was taken from the materials in Experiment 1. The text's (1) topic was genetic manipulation, and the question (2) was one of the four bridging inference questions. Both were translated from the original Dutch materials:

1. Genetically manipulated organisms can cross with natural plants. The new organisms that arise because of this are resistant against insects and pesticides, whereas the natural organisms are not. The natural plants die out and as a consequence the bio-diversity of the natural flora is

threatened, as well as biological agriculture that wants to remain free of genetic manipulation.
2. Question: The text states that genetic manipulation can possibly endanger the diversity of natural flora. Explain in what way.

To answer this bridging inference question correctly, a reader had to link information from the second sentence (*pesticides are only dangerous to natural organisms*) to information from the third sentence (*natural organisms die, diversity decreases)* and to establish a causal relation between these events.

Participants. Prior knowledge was operationalized by an expert–novice paradigm (see the previous section under the following heading: Operationalizations of Text Comprehension, Coherence Marking, and Prior Knowledge) because this method makes use of existing knowledge structures, thereby creating a large knowledge difference between both groups. Eighty students of Utrecht University participated in this experiment: 26 history students and 54 biology students. We expected the biology students to know significantly more about genetic manipulation and organ donation. This assumption was validated by asking four prior knowledge control questions prior to the experiment. These questions concerned basic principles in genetics and anatomy. A t test showed that the groups indeed differed significantly on prior knowledge—$t(79) = -10.59$, $p < .001$—with biology students scoring higher than history students. The *a priori* groups represented two distinct levels of prior knowledge and were considered as low knowledge and high knowledge readers for the following analyses.

Design. Prior knowledge was a between-subject factor with values high and low. Text version was a between-subject factor with the values no marking and with marking.[1] There were also two genres (informative and persuasive) and two text topics (genetic manipulation and organ donation). In total, we used eight different texts in this experiment: 2 Topics × 2 Versions × 2 Genres. These factors were integrated in a Latin square design: Every participant read two texts, one of which was implicit and the other explicit, one of which persuasive and the other informative, one of which on genetic manipulation and the other on organ donation. The experiment took about 40 min. Participants were instructed not to turn back the pages they had already read.

[1]Every participant read one implicit and one explicit text, meaning that text version was measured as a within-subjects variable. However, genre was also assessed as a within-subjects variable: Every participant read one informative and one persuasive text. To separate the two text genres in the analyses, text version was analyzed as a between-subject variable.

Results

We present the results for the informative and persuasive genre separately. Two-way analyses of variance (ANOVAs) were calculated to test the effects of marking of coherence and prior knowledge on text comprehension. When we included text topic as a factor, there was no significant main or interaction effect of text topic. Therefore, we combined both text topics in the following analyses.

The answers to the open-ended questions were scored as follows: 0 = incorrect, 0.5 = unclear, 1 = correct. This approach to scoring did not present any problems because most of the answers clearly were either correct or incorrect. The doubtful answers were scored with the help of an expert in biology, and they were mostly attributed a score of 0.5. Internal reliability between the questions was measured with Cronbach's alpha: For the genetic manipulation text, $\alpha = 0.33$; for organ donation, $\alpha = 0.45$. These results were disappointing (see also the Discussion section and Experiments 2 and 3). Nevertheless, we still analyzed the effects of coherence marking and prior knowledge on text comprehension by combining the open-ended questions in our analyses.

In the informative genre, we found an interaction effect of coherence marking and prior knowledge on comprehension, $F(1, 77) = 3.72, p < .05, \eta^2 = .05$. Low knowledge readers performed better after reading the explicitly marked text than after the implicit version, $t(24) = -1.80, p < .05$. High knowledge readers performed equally well on both versions, $t(53) = .77, p > .4$. There was also a significant main effect of prior knowledge, $F(1, 77) = 15.49, p < .01, \eta^2 = .17$: High knowledge readers performed, in general, better than low knowledge readers.

For persuasive texts, the situation differed, as is represented in the last two columns of Table 1. There was no interaction effect, but there was a main effect of marking of coherence, $F(1, 75) = 2.72, p = .05, \eta^2 = .04$; and of prior knowledge, $F(1, 75) = 10.40, p < .01, \eta^2 = .12$. On average, high knowledge readers performed better than low knowledge readers. Comprehension scores were higher after having read the explicit version than after the implicit version.

TABLE 1
Comprehension Scores From Experiment 1 on a Scale Ranging From 0 (*Minimal Understanding*) to 4 (*All Questions Correct*) for Informative and Persuasive Texts

	Informative No Marking		*Informative With Marking*		*Persuasive No Marking*		*Persuasive With Marking*	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Less prior knowledge	1.38	0.77	1.93	0.76	1.46	0.78	1.92	0.76
More prior knowledge	2.44	0.75	2.29	0.76	2.22	0.75	2.39	0.85

Conclusion

For the informative genre, McNamara and Kintsch's (1996) interaction effect of prior knowledge and marking of coherence was replicated with texts that were systematically varied in the linguistic marking of coherence relations and text structure. Low knowledge readers benefited from an explicit text, whereas high knowledge readers performed equally after reading either text. The latter finding differs form McNamara and Kintsch's findings: For their high knowledge readers, the implicit version caused significantly better understanding.

In the persuasive texts, the explicit version was beneficiary for both groups. A very important point of concern is that the open-ended comprehension questions were not internally reliable. Therefore, we decided to replicate the experiment with a different text comprehension method: the sorting task (McNamara & Kintsch, 1996).

EXPERIMENT 2

The second experiment was a replication of Experiment 1, with a few adaptations. First, the method to assess comprehension was changed to a sorting task because of the low internal reliability of the bridging inference questions (see Experiment 1). This is a problem that often occurs when using open questions to assess text comprehension (e.g., see McNamara et al., 1996, Experiment 1). In an experiment in which we compared different text comprehension methods, we found that the sorting task was the most reliable operationalization of text comprehension (Kamalski, Sanders, Lentz, & van den Bergh,). Consequently, we used a sorting task to replace the open-ended questions.

Experiment 2 also manipulated the marking of relational coherence, but not the marking of referential coherence. In doing so, marking of coherence was manipulated in a more homogenous way than in Experiment 1. We manipulated the marking of global coherence relations (headings and organizers) and marking of local coherence relations (connectives and lexical cue phrases) in the same way as in Experiment 1.

Method

Materials. We used the materials from Experiment 1, but with a different measure of text comprehension: a sorting task. In a sorting task, a respondent has to categorize key concepts from a text according to the text (McNamara & Kintsch, 1996). Our sorting tasks resembled McNamara and Kintsch's, but they were scored in a different way. The sorting tasks were constructed as follows: Key words and concepts were selected for each text (approximately 20 words per

text). These concepts played an important role in the argumentational structure of the text. The choice of concepts was determined by the principle that they should enable the respondent to reconstruct the rationale behind the text. With these 20 concepts, a model was constructed in which these concepts were linked in the same way as the text did. For example, causes were linked to their consequences, or examples of the same phenomenon were linked. This model was used in a normative way, meaning that the participant's responses were compared to the model to decide whether their answer was correct. Several linguistic experts agreed on both the choice of concepts and the categorization that together formed the normative model. Example 1 was part of the sorting task for the genetic manipulation text:

(1) "Here's a list of key words taken from the text. Make groups of words that you think should go together on the basis of the text. You can make as many groups as you want, and they can be of any size. Draw a circle for each group you want to make and put the right numbers in the circle."

1. Solving the world hunger problem.
2. Crossing existing crops.
3. Moratoria.
4. Disease control, and so forth.

According to the normative model, Key Concepts 1 and 4 had to be categorized together because they both represent advantages of genetic manipulation. Key Concepts 2 (an original application of genetic manipulation) and 3 (a solution for the environmental problems that genetic manipulation may cause) did not belong in that same group. The participant's score was calculated by counting the number of items that were categorized together according to the normative model. Suppose a participant would categorize the previous example as follows: 1, 4, and 3 together and 2 apart. Out of a possible four items to be categorized correctly, this participant would receive a score of 3 because Items 1, 4, and 2 were categorized according to the model. Item 3 was misplaced in a group where it did not belong and, therefore, this item did not result in any points. If participants combined two or more groups into one big group, the score was lowered by 0.5 points per combination. In the case of our example, one single group of 1, 2, 3, and 4 would result in a score of 3: The category was combined with two others, lowering the score by 1 point. Finally, we calculated the proportion of correctly categorized items, and multiplied the proportion by 10, thereby creating a scale from 1 to 10. The final sorting scores range from 0 (*no correctly sorted items*) to 10 (*all items correctly sorted*).

TABLE 2
Comprehension Scores From Experiment 2 From the Sorting Task, on a Scale Ranging From 1 (*Very Low*) to 10 (*Very High*) for Informative and Persuasive Texts

	Informative		*Persuasive*	
Text version	*M*	*SD*	*M*	*SD*
Without marking	6.04	2.15	6.03	2.33
With marking	6.49	2.21	6.70	2.27

Participants. As in Experiment 1, we used an expert–novice paradigm. Sixty-seven medical students participated in the high knowledge group, and 64 law or history students participated in the low knowledge group. We expected the medical students to have more prior knowledge about organ donation and genetic manipulation than law students. This expectation was confirmed: $t(129) = -20.3$, $p < .0001$.

Results

The reliability for the sorting tasks and Cronbach's alpha was considerably higher than in Experiment 1 (for genetic manipulation, $\alpha = 0.56$; for organ donation, $\alpha = 0.64$).[2] Just as in Experiment 1, text topic did not influence the results; therefore, we collapse over text topic in our presentation of the results. We calculated two-way ANOVAs to test the effect of coherence marking and prior knowledge on text comprehension. The results in Table 2 show that there was a main effect of marking of coherence for the persuasive genre, $F(1, 125) = 2.83$, $p = .05$, $\eta^2 = .14$; but there was no effect for the informative genre (ns, $p > .1$). In both genres, there was no interaction with prior knowledge. Therefore, the mean scores reported in Table 2 are for both knowledge groups combined.

A comparison between Experiments 1 and 2 indicates that the low knowledge readers behaved exactly the same in Experiments 1 and 2: They performed better on comprehension questions after having read the explicit text in the informative genre and in the persuasive genre. However, in Experiment 1, genre interacted with the effect of prior knowledge on text comprehension, $F(1, 104) = 8.62$, $p < .05$, $\eta^2 = .08$; but in Experiment 2, we do not see this effect, $F(1, 135) = 1.02$, $p > .3$. For the high knowledge group, there were differences

[2]Cronbach's alpha should be higher than 0.7 for a method to be reliable (van Wijk, 2000). However, because of the low reliability scores of text comprehension methodology in the previous experiments, we chose to accept this reliability of 0.6.

between the two experiments. In Experiment 1, they performed equally well after having read an implicit or an explicit informative text. In Experiment 2, they performed better after having read an explicit informative text.

Conclusion

In Experiment 2, we have found again that coherence marking led to better comprehension for texts in the persuasive genre, just as we did in Experiment 1. For the informative genre, there were no significant effects. This result differs from Experiment 1, where we clearly saw an interaction between coherence marking and prior knowledge in the informative genre.

One wonders why the two experiments differed for the sorting tasks and question-answering task. Does this imply that the sorting task is not a valid assessment of situation model representations? The sorting task has been criticized for simplifying the mental representation that a reader constructs. Another consideration is that we used post-measurements only, whereas McNamara and Kintsch (1996) compared pre- and posttests. Although it is possible that the sorting task may be responsible for the difference between Experiments 1 and 2, such an explanation would not account for the fact that the results for the persuasive genre *were* replicated. However, there are many other possible reasons for the differences between Experiments 1 and 2. In Experiment 2, referential coherence was no longer manipulated. In Experiment 2, the high knowledge readers were students in medicine, whereas they were biology students in Experiment 1. Finally, there is the principled point that, under the paradigm we had chosen, researchers cannot control the exact prior knowledge experts have. The experts have more knowledge than the novices, but what exactly do they know? In Experiment 1, this operationalization worked, whereas the same operationalization led to some problems in Experiment 2. We conclude that we need to control the variable prior knowledge better to solve this problem. Therefore, in the next experiment, we use an alternative paradigm: We provide instructions to "create" the high knowledge readers.

EXPERIMENT 3

Experiment 3 was an adaptation of Experiment 2. Materials and assessments were kept constant. Prior knowledge was manipulated by giving instructions. It is often argued that interactive lessons in reading experiments are to be preferred over written instruction because of the *modality effect* (Moreno & Mayer, 1999)—that is, students are expected to learn better when verbal input is presented auditorily as speech rather than visually as text. In contrast, a downside to the use of interactive lessons in the context of reading experiments is that for

every session the same interactive lesson needs to be taught. Unfortunately, interactive lessons depend on the input of the participants, which makes it impossible to keep the content absolutely constant. Therefore, we chose another method to provide participants with the necessary prior knowledge: through short movie clips. These clips explained in a simple way how complex processes, such as genetic manipulation, work. Every time they were played in an experimental context, they were exactly the same. Once again, the modality effect is still an excellent reason to prefer a movie clip over a text booklet.

Method

Materials. Prior knowledge was attributed through two short movie clips of approximately 15 min. The clips were chosen on the basis of two criteria: First, they had to have as little overlap with the content of the actual experimental texts as possible. Second, they had to activate relevant concepts and explain basic ideas that were necessary for comprehension of the experimental materials. We chose clips that applied the necessary knowledge by analogy to a slightly different but related situation. For instance, the genetic manipulation movie clip explained the process of manipulation of viruses and bacteria. This explanation would make it easier to understand the consequences of genetic manipulation in plants, which was put forward in the text. The organ donation movie clip introduced the technique of transplanting animal organs in human bodies. By explaining this whole process, the actual process of human organ transplantation as well as the risks involved were expected to become clearer to the participants.

Participants. The participants were 255 undergraduate students from Utrecht University. They were selected for being novices in the domains of organ donation and genetic manipulation. The necessary prior knowledge was given to them for one of these two topics through the movie clip. No prior knowledge was provided for the other topic, so that they remained novices with respect to this topic. The success of this paradigm was tested by means of three control questions for each topic. The analyses showed that this technique of providing the necessary knowledge did have the desired effect: After having seen the movie clip on genetic manipulation, participants had more knowledge about genetic modification—$t(208) = 5.60$, $p < .0001$, $\eta^2 = .13$—than those who had not seen the movie clip. The same effect occurred for organ donation, $t(205) = -4.70$, $p < .0001$, $\eta^2 = .10$. For both clips, scores on prior knowledge questions were significantly higher after having seen the movie clip.

Design and procedure. Prior knowledge was a between-subject factor. One half of the participants saw the movie clip about genetic manipulation, whereas the other half saw the movie clip for organ donation. These clips were

shown to the participants in groups of approximately 25. After the clip, they read two texts: one on each topic, one implicit and one explicit text, and one informative and one persuasive text. The Latin square design was the same as in Experiment 1 and 2.

Results

The sorting tasks were analyzed in the same way as in Experiment 2. In addition, they were scored by two different raters. The interrater reliability for these 102 observations was calculated with a correlation coefficient: $r = .93$. Also, the internal reliability was acceptable: $\alpha = 0.60^2$. Again, as in Experiments 1 and 2, we performed two-way ANOVAs to investigate the effects of prior knowledge and coherence marking on comprehension.

We first report the results for the informative genre. We found an interaction effect of coherence marking and prior knowledge, $F(1, 238) = 8.03, p < .01, \eta^2 = .03$. When analyzing both text topics separately, there were two similar interaction effects—genetic manipulation: $F(1, 154) = 3.81, p < .05, \eta^2 = .05$; organ donation: $F(1, 116) = 5.70, p < .05, \eta^2 = .05$. These interaction effects were not identical, but they both lead to the same conclusion concerning the interaction of coherence marking and prior knowledge. Therefore, these results were collapsed and presented together in Figure 1.

In this interaction, the low knowledge group performed better after having read the explicit version than after having read the implicit version, $t(116) = 1.97, p < .05$. For the high knowledge group, there was the opposite effect: The implicit version yielded better comprehension scores than the explicit version, $t(122) = 2.01, p < .05$.

For the persuasive genre, the results showed neither an interaction with prior knowledge nor a main effect of prior knowledge, but rather a main effect of coherence marking. The explicit text yields higher results on the sorting task than the implicit text. This effect is significant for the organ donation text, $F(1, 120) = 58.78, p < .04, \eta^2 = .98$; whereas for the genetic modification text there was only a trend toward significance ($p < .1$; see Figure 2).

Conclusion

In summary, we have found evidence for the interaction between coherence marking and prior knowledge. The most trustworthy results were found in Experiment 3. The results from Experiment 3 were clear, reliable, and based on an improved text and methodology compared to Experiments 1 and 2. We had the factor prior knowledge under experimental control, and we used a more reliable text comprehension method.

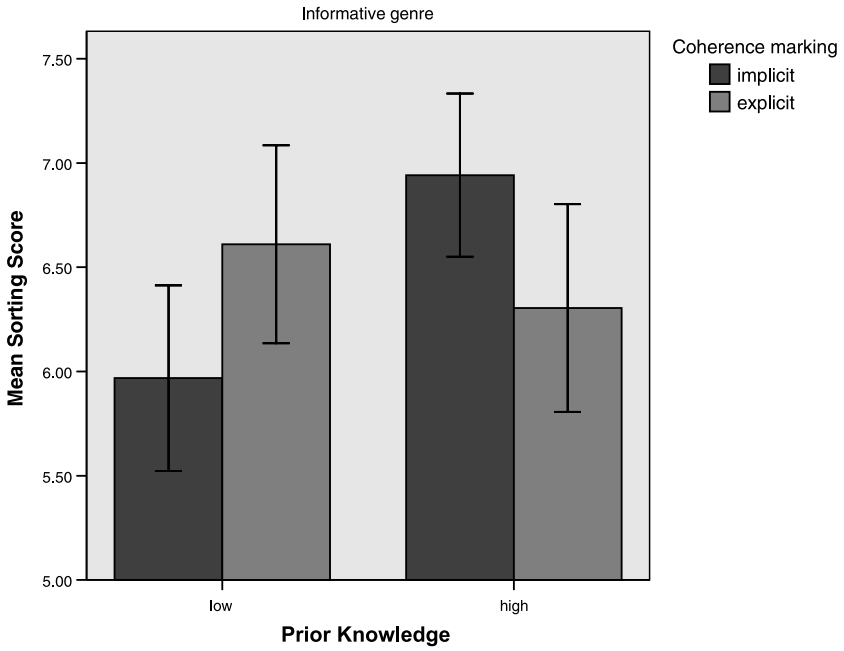

FIGURE 1 Comprehension scores from Experiment 3 on a scale ranging from 1 (*low*) to 10 (*high*) for the informative genre for both knowledge groups.

According to Experiment 3, prior knowledge and coherence marking interacted for informative texts. Low knowledge readers benefited from the explicit texts: These texts resulted in better text comprehension. However, high knowledge readers performed better after having read implicit texts, probably because these texts caused them to process deeper and more thoroughly than when they read the explicit text. This result replicated the findings by McNamara and Kintsch (1996). For persuasive texts, there was no such interaction: The explicit text was the most beneficiary for text comprehension. In Experiment 3, this main effect was only observed for the organ donation text, whereas in the other two experiments the effect was observed for both texts.

Additional Analyses

Why did we see no interaction in the persuasive genre, as opposed to the informative genre? A detailed look at the data shows that for low knowledge readers there was no difference in the effect of coherence marking between both genres, $F(1, 234) = 0.01, p > .9$. In both cases, low knowledge readers

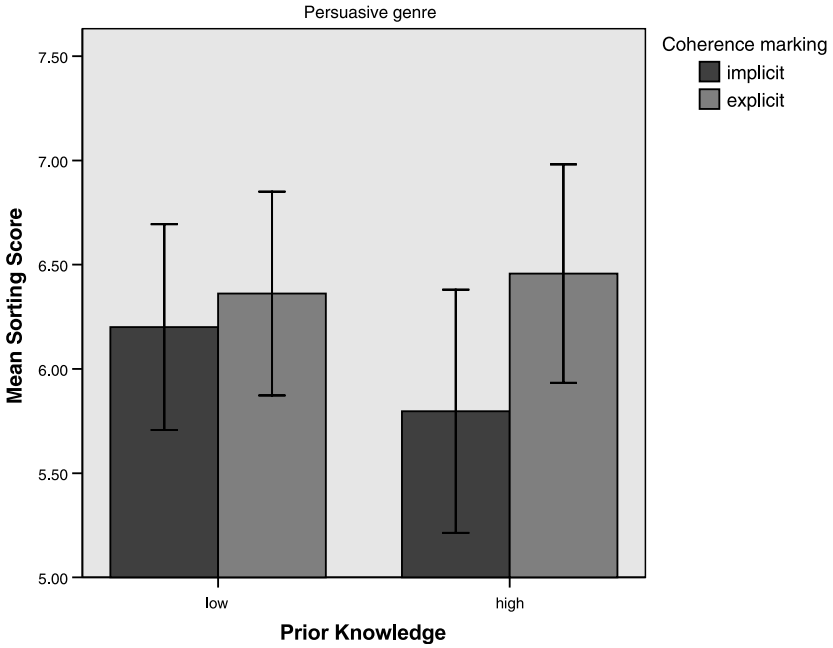

FIGURE 2 Comprehension scores from Experiment 3 on a scale ranging from 1 (*low*) to 10 (*high*) for the persuasive genre for both knowledge groups.

benefited from an explicitly marked text, whether the text is informative or persuasive. This effect can be explained by the integration and inference function of coherence markers—that is, the markers helped low knowledge readers integrate text segments and infer causal relations (Noordman & Vonk, 1997).

On the other hand, for high knowledge readers, the effect of coherence marking differed as a function of genre, $F(1, 246) = 3.8, p < .05, \eta^2 = .05$. When reading informative texts, high knowledge readers benefited from an implicit text that apparently caused deeper processing and comprehension. In other words, because the text did not help them, they were forced to integrate and infer ideas all by themselves. This deeper processing resulted in better comprehension (McNamara & Kintsch, 1996). Contrastively, in the persuasive genre, the beneficiary effect of the absence of markers on comprehension was not present.

The sorting tasks for the informative and the persuasive texts were identical, so we were able to compare these scores on comprehension between genres. When we look at Figure 1, we see that in the informative genre, high knowledge readers performed on average 6.94 in the implicit condition; but in the persuasive

genre, they performed on average 5.79 in this condition. This was a significant difference, $t(124) = 3.26$, $p < .01$. For the explicit version, there was no such difference between the informative genre and the persuasive genre ($p > .05$). These analyses help refine our question: Why did results on comprehension for the high knowledge readers on the implicit text change so much from one genre to another? We elaborate on this question in the following section.

GENERAL DISCUSSION

The most important result from the three experiments in this article is the replication of McNamara and Kintsch's (1996) interaction effect of coherence marking and prior knowledge on text comprehension. However, this time the study is on texts that were systematically varied in the linguistic marking of coherence relations and text structure. In our experiments, only purely linguistic markers of coherence were manipulated. It was shown how low knowledge readers benefited from explicit texts, whereas high knowledge readers performed better after having read implicit texts. However, the replication of this interaction effect of coherence marking and prior knowledge seemed to depend on the precise operationalization of important variables.

Presumably, there are advantages to operationalizing prior knowledge with an expert–novice paradigm, thereby making use of elaborate stable knowledge structures, but this was not the most stable operationalization in our experiments. The experts in Experiment 1 behaved differently than the experts in Experiment 2, but the novices behaved in exactly the same way in both Experiments. A more precise manipulation of expert knowledge is needed because we did not seem to have expert knowledge under control. The conclusion that the instruction paradigm is the most successful operationalization of prior knowledge is contrary to our intuitive expectation: One would expect the expert–novice paradigm to be more stable because it relies on extensive knowledge structures that have been established over years. Our conclusion is even more remarkable because it is contrary to earlier findings by McNamara and Kintsch (1996), where instruction did not have the expected effects.[3]

How can operationalizations that simply provide instruction and knowledge during 30 min be more reliable? In our view, the most plausible answer is that

[3]There is one very important difference between the instruction of McNamara and Kintsch (1996) and the one we used; the medium. McNamara and Kintsch used a pretraining booklet before having participants read the text, whereas we used a movie clip. According to the modality principle (Moreno & Mayer, 1999), the use of audio or video to explain a textual presentation enhances understanding. In our experiments, we used video to provide knowledge about the subsequent texts: video and textual information. The movie clip did, in fact, create a learning effect, whereas the pretraining booklet does not seem to cause such an effect.

the movie clips activated (in the sense of Anderson, 1984) the participants' representation of relevant target concepts in the text. The movie clips did not provide *literally* the same information as the text did. They rather presented analogies and parallel situations to the ones in the text. For instance, when the text explained genetic manipulation in plants and food, the movie clip explained the process of human genetic manipulation. By providing equivalent but not identical information, the relevant concepts were probably activated in the reader's knowledge structure, leading to an increased use of the relevant domain knowledge that experts have. Activation may play a lesser role when an expert–novice paradigm is used because the researcher relies on the expert's elaborated knowledge structures that novices do not have. Under that paradigm, it is unknown to what extent experts actually activate this knowledge during processing. Hence, the reason why the operationalization of prior knowledge was most reliable when an instruction with a movie clip was given may be that the relevant concepts were activated in the reader's knowledge base. Clearly, further research is needed to confirm this tentative explanation.

We have seen a similar importance of operationalization in text comprehension when we consider sorting tasks as potentially more reliable than open-ended questions. The same relative reliability of the sorting task was observed in earlier experiments (Kamalski et al., 2007). Although sorting tasks have been criticized among others for being too simplistic (Kintsch, 1998), we do believe sorting tasks are very useful methods for measuring text comprehension.

A third goal of our experiments was to compare effects of coherence marking and prior knowledge on text comprehension in two different text genres. The effects of coherence marking and prior knowledge in persuasive contexts seem to differ from those in informative contexts: We did not find the interaction effect that was present in the informative genre, but rather a main effect of coherence marking. In the additional analyses for Experiment 3, we refined the crucial question to inquiring whether the results for high knowledge readers on the implicit text change so much from one genre to another. Although we do not yet have any final answers to this question, we would want to offer some speculations. In an informative context, high knowledge readers use extra processing effort to process the implicit text deeper. In the persuasive context, however, they have the same extra processing effort at their disposal, but the context makes them use it differently: A persuasive context causes readers to judge and evaluate; to form, change, or maintain an opinion; to engage in counter-argumentation; and so on. Because cognitive processing capacity is limited (Cognitive Load Theory; Paas, Tuovinen, & Van Gerven, 2003), there is not enough cognitive energy left for deeper processing that is needed to make up for the absence of coherence marking. This might be the reason why, in the persuasive context, high knowledge readers do not benefit from the implicit text.

The resources that could be used to process deeply to benefit from such a text are invested in other, persuasion-related cognitive processes and are not used for text comprehension to the same extent. Processing data need to be obtained to investigate this tentative explanation further.

Although we can only speculate about the exact explanation for the differences between both genres, we have shown how useful it is to compare text genres by using texts that largely share the same content, but present this information in a different context. Furthermore, studying more than one genre provides more insight into the functions of coherence marking. The context in which the markers are presented influences the effects they have on comprehension. Secondary task methodology (Paas, Renkl, & Sweller, 2003) could be a helpful method to test whether our cognitive effort explanation for the difference between the informative and the persuasive genre is indeed a valid one. We are in need of precise processing data to better understand the observed differences. This is definitely the next step that needs to be taken. Also, future experiments need to include more texts so that we are able to generalize over texts and text genres because the texts in these experiments did not consistently cause the same effects. For example, in Experiment 3, two similar but not identical interaction effects were found. Although these effects did not lead to different conclusions, they were not identical. Therefore, follow-up experiments need to include more texts for each genre.

The results suggest that coherence markers indeed guide the interpretation process and result in a text that is more easily understood. However, coherence markers have more effects than that. In persuasive text, coherence markers may make the process of understanding easier, and the extra cognitive resources available are then attributed to other cognitive activities, such as weighing information in the text carefully and forming an opinion. This might imply that coherence markers not only affect comprehension, but also persuasion. More research is needed to determine whether coherence markers also influence the persuasive power of a text, and how; in fact, we have started doing that (Kamalski, Lentz, Sanders, & Zwaan, 2007). For now, we conclude that coherence markers are potential powerful tools in discourse. They play an important role in improving the cognitive representation of readers who do not have much content knowledge of the text topic.

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APPENDIX

Examples of Experimental Materials

1. Passage from informative genetic manipulation text, translated from Dutch (markers are underlined, [type of marker])
   What are the consequences of genetic manipulation? [heading]
   Different point of views exist on the pros and cons of genetic manipulation. [organizer] The food industry says that genetic manipulation offers many advantages, since [connective] it enables us to start resolving world hunger. Moreover, [connective] genetic manipulation can help us fight illnesses in the future that are now incurable.
   Environmental organizations say that genetic manipulation is an unacceptable change in nature, because [connective] it creates safety risks that the

consumer is not fully aware of. An example of such a risk [lexical cue phrase] is public health. Consumers can accidentally swallow remainders of herbicide. (. . .)

In summary, [lexical cue phrase] genetic manipulation has good and bad sides to it. The future will show whether it/genetic manipulation [referential coherence] is a beneficiary development or not.

2. Passage from persuasive genetic manipulation text (markers are underlined, [type of marker])

What are the dangers of genetic manipulation? [heading]

Different point of views exist on the pros and cons of genetic manipulation. [organizer] The food industry says that genetic manipulation offers many advantages, since [connective] it enables us to start resolving world hunger and fight illnesses in the future that are now incurable.

Despite these advantages, genetic manipulation remains an unacceptable change in nature, because [connective] it creates safety risks that the consumer is not fully aware of. The food industry completely ignores these risks/risks of genetic manipulation. [referential coherence] An example of such a risk [lexical cue phrase] is public health. Consumers can accidentally swallow remainders of herbicide. (. . .)

Therefore, there is [connective] only one clear answer to genetic manipulation: stop eating genetically manipulated food. Biological foods are safer for the environment, for agriculture, and for the consumer.