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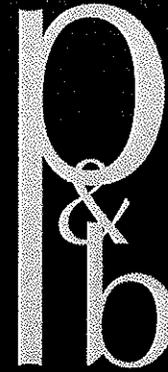
Constraints in Discourse

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# Constraints in Discourse

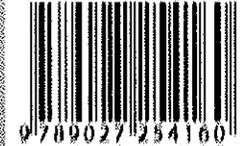
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**Volume 172**

Constraints in Discourse  
Edited by Anton Benz and Peter Kühnlein

## **Constraints in Discourse**

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## Accessing discourse referents introduced in negated phrases

### Evidence for accommodation?

Barbara Kaup and Jana Lüdtké  
Berlin University of Technology

In two experiments we compared anaphor resolution times in negative sentences (e.g., *Either Peter does not catch a train, or it will arrive late in the evening.*) with those in affirmative sentences (e.g., *If Peter catches a train, then it will arrive late in the evening.*). Sentences were read segment-by-segment, and segment reading times were being recorded. In line with the hypotheses, segment reading times following the anaphoric expression were longer in the negative than in the affirmative condition, but only when the critical entity was being referred to (e.g., the train as compared to Peter). When instead of a pronoun a repeated-name was being used for reference (e.g., *the train* as compared to *it*), resolution times were faster specifically in the negative condition. Implications for different accounts of language comprehension are discussed.

#### 1. Introduction

According to proponents of dynamic semantics, the meaning of a sentence is not defined in terms of its truth conditions but rather in terms of its potential to change the context in which it occurs. This concept of meaning as context-change potential is central, for instance, in Heim's *File-Change Semantics* (Heim 1982) or Kamp's *Discourse-Representation Theory* (DRT, Kamp 1981). According to these theories, a sentence containing an indefinite noun phrase (NP) [such as *a lion* in (1a)], introduces a discourse referent into the discourse representation, and this discourse referent can be utilized when in the upcoming text the respective entity is being referred to (e.g., 1b, see Figure 1). Thus, such a sentence changes the context by providing a discourse referent to which upcoming text can be related. Accordingly, dynamic semantics is particularly well suited to account for anaphoric binding across the sentence boundary.

- (1) a. In the cage there was a lion.  
b. It was sleeping and snoring.

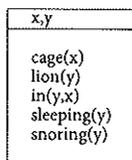


Figure 1. Discourse representation for text (1).

Negation provides an interesting case in this context: An indefinite NP in the scope of the negation operator introduces a discourse referent. However, this discourse referent is usually not available for anaphoric reference in the upcoming text. For instance, in (2), the anaphoric reference in the second sentence seems awkward. This apparent inaccessibility is accounted for by assuming that negation is an operator that applies to a sub-ordinate DRS, and that discourse referents represented in a negated sub-DRS are inaccessible for anaphor resolution in the main-DRS (see Figure 2).<sup>1</sup>

- (2) a. In the cage there was no lion.  
b. \*It was sleeping and snoring.

However, under certain conditions, anaphoric reference to entities introduced within the scope of the negation operator is possible. For instance, in (3) where the lion is introduced within the scope of a double negation, anaphoric reference is felicitous. It seems that comprehenders resolve the double negation, to the effect that the respective discourse referent is accessible for anaphor resolution in the second clause. This *accommodation* process (Lewis 1979) is licensed in cases where the original DRS is logically equivalent to the transformed DRS: The negation of the negation of a proposition *p* is logically equivalent to the proposition *p*. Accordingly, accommodation can transform a DRS that is negated twice into a DRS that is not negated at all (see Figure 3). It is usually assumed that accommodation is triggered by the encounter of an anaphoric expression that can otherwise not be resolved. In other words, accommodation does not take place spontaneously but only when it is required for anaphor resolution (cf. Kuschert 1999).

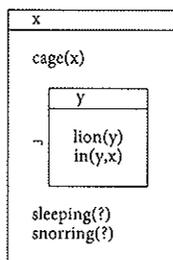


Figure 2. Discourse representation for (2). The pronoun in the second sentence cannot be resolved because no adequate discourse referent is accessible in the main DRS.

1. Note, the cage is not a potential referent because the verb in the anaphoric sentence requires an animate subject.

- (3) a. It's not true that there was no lion in the cage.  
b. I saw it sleeping and heard it snoring.

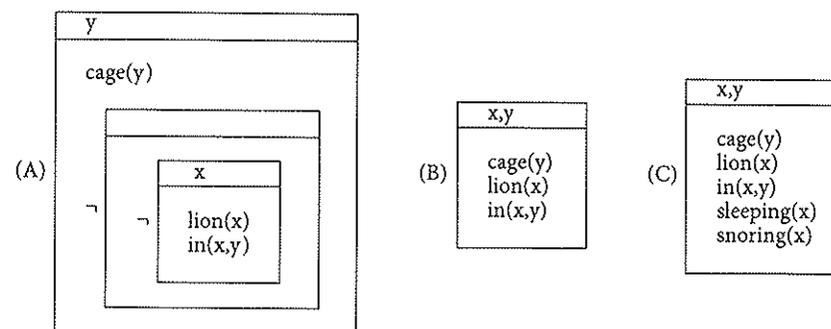


Figure 3. A: Discourse representation for (3a). B: Discourse representation after the accommodation process has taken place: The discourse referent representing the lion is accessible in the main-DRS. C: Discourse representation for the whole discourse after successful anaphor resolution.

The assumptions concerning accommodation directly translate into hypotheses concerning the time that is required for anaphor resolution in language comprehension. An anaphoric expression with an antecedent in the scope of a double negation [e.g., (3)] should take longer to resolve than an anaphoric expression with an antecedent in an affirmative phrase [e.g., (4)]. The reason is that the former triggers a time-consuming accommodation process. Once the anaphor is resolved, the two conditions should not differ with respect to the accessibility of the introduced discourse referents, because the accommodation process modifies the discourse representation. Thus, if an anaphoric expression is used for the second time, no difference should emerge between the two different antecedent conditions [i.e., (3) and (4), respectively].

- (4) a. It is true that there was a lion in the cage.  
b. I saw it sleeping and heard it snoring.

The first of these two predictions was investigated in a self-paced reading experiment by Kuschert (1999). Participants were presented with narrative texts in which a target entity (in the following *critical entity*) was introduced either within the scope of a double negation or within an affirmative phrase [e.g., (5) and (6), respectively]. The next sentence then referred to this entity by means of a pronoun. Sentences were being presented segment-by-segment, and segment reading times were being recorded [segment borders are indicated by a “/” in (5) through (8) below].

As predicted, reading times for the segment following the pronoun (i.e., *in the mall today*) were significantly longer in the negative than in the affirmative condition. This is in line with the idea that comprehenders, upon encountering the pronoun in the anaphor sentence, initiated a time-consuming accommodation process in the negative condition

(see Figure 4). Interestingly, the same result was not obtained in two control conditions [(7) and (8)], where the anaphor sentence did not refer to the critical entity but to an entity that was mentioned in the previous sentence by means of a proper name or a definite NP (e.g., Jim; in the following: *non-critical entity*). The respective discourse referent was not introduced but only referred to in the previous sentences and should therefore be represented in the accessible main-DRS right away, even in the negative condition (see Figure 4). The fact that the negation effect did not generalize to these conditions rules out the possibility that the prolonged reading times in the negative condition reflect general processing difficulties subsequent to negative sentences (for instance due to spill-over effects).

- (5) a. Mary denied / the statement / that Carl / does not have a sister.  
b. She had met her / in the mall today.
- (6) a. Mary confirmed / the statement / that Carl / has a sister.  
b. She had met her / in the mall today.
- (7) a. Mary denied / the statement / that Carl / does not have a sister.  
b. She had met him / in the mall today.
- (8) a. Mary confirmed / the statement / that Carl / has a sister.  
b. She had met him / in the mall today.

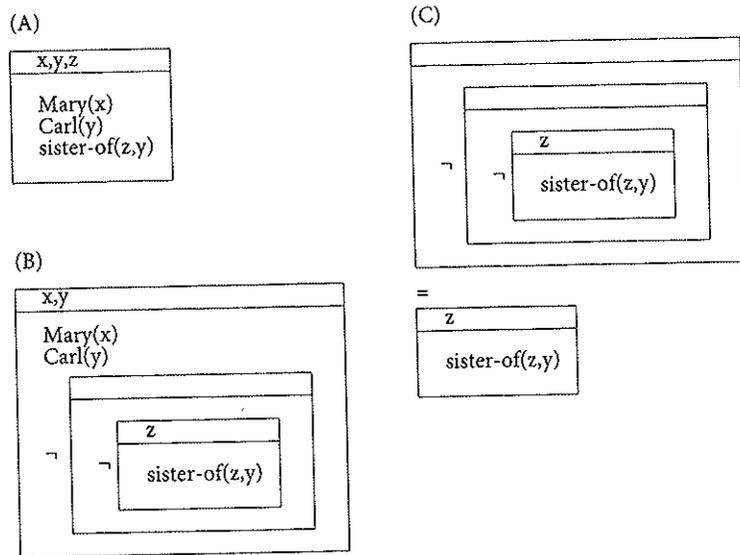


Figure 4. A: Discourse representation for (6a). B: Discourse representation for (5a). C: Accommodation: Logical equivalence of *not not P* and *P*. The representation in A corresponds to the representation for (5) a after accommodation has taken place. Note: This figure is slightly simplified: *Mary denied that P* is reduced to *Not P*, and *Mary confirmed that P* is reduced to *P*.

By the same reasoning as above, Kuschert also investigated anaphor resolution in so-called *bathroom sentences* [e.g., (9)].<sup>2</sup> Here, the anaphor refers to an entity that was introduced within the scope of a negation operator in the first clause of the sentence. The respective discourse referent is represented in a negated sub-DRS, and accordingly, should be inaccessible for anaphor resolution in the second clause (see Figure 5A). Accommodation in this case presumably utilizes the fact that *Not-a or b* is logically equivalent to *If a then b*. In DRT it is generally assumed that discourse referents represented in the sub-DRS that corresponds to the antecedent of an implication are accessible from within the sub-DRS that corresponds to the consequent of the implication. Thus, accommodation in this case should be successful, because subsequent to the accommodation process, the critical discourse referent is available for anaphor resolution from within the sub-DRS containing the respective proposition (see Figure 5B). Thus, translated into predictions concerning the time that is needed for anaphor resolution, we would expect to find longer resolution times for the anaphor in bathroom sentences compared to the corresponding affirmative implication [e.g., (9) and (10), respectively]. As before, this difference should only be obtained when the anaphor refers to the critical entity, but not when it refers to the non-critical entity [as in

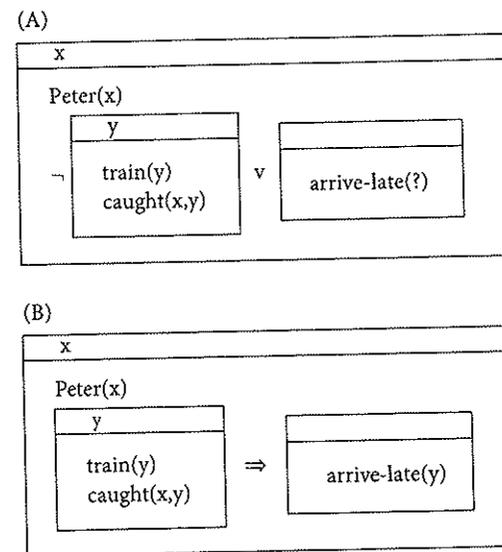


Figure 5. A: Discourse representation for (9). B: Discourse representation for (10). Note: The representation in B corresponds to the representation for (9) after accommodation has taken place.

2. The term is due to a structurally similar example attributed to Barbara Partee, namely *Either there is no bathroom in this house, or it is in a funny place.*

(11) and (12)]. The results of Kuschert's experiment corresponded to these predictions: The segment following the anaphor (i.e., *arrive very late*) was read more slowly when the antecedent was in the scope of a negation operator [(9)] than when it was in an affirmative phrase [(10)]. Furthermore, when instead of the critical entity (i.e., train) the non-critical entity was being referred to [(11) and (12)] the negative condition did not lead to longer reading times than the affirmative condition. Thus, the results obtained with these materials replicated the results obtained with double negation.

(9) Either Peter did not / catch a train, / or it will / arrive very late / in the evening.

(10) If Peter / caught a train, / it will / arrive very late / in the evening.

(11) Either Peter did not / catch a train, / or he will / arrive very late / in the evening.

(12) If Peter / caught a train, / he will / arrive very late / in the evening.

To summarize, the results of Kuschert's study fit nicely with the predictions of the accommodation hypothesis. Anaphors referring to entities that were introduced in the scope of a negation are more slowly resolved than those referring to entities introduced in affirmative phrases, presumably because they trigger a time-consuming accommodation process. However, in an earlier study conducted in our lab (Kaup, Dijkstra, and Lüdtkke 2004), we failed to replicate Kuschert's results in several experiments employing sentences with **double negation**. Instead of finding evidence for a temporary inaccessibility of the critical entity in the negative condition, we found evidence for a relatively high accessibility of this entity. Obviously, this is in contrast to the predictions of the DRT-based accommodation hypothesis. Before reporting two new experiments in which we tried to replicate Kuschert's result obtained with **bathroom sentences**, let us take a closer look at our study with double negation.

## 2. Previous Study: Double Negation

In the first experiment we attempted to replicate the results by Kuschert. Participants were presented with narrative stories containing passages such as (5)–(8), and sentence reading times were being measured (see Table 1, for an example). Reading times for the anaphoric sentences were analyzed. Reading times were longer in the negative than in the affirmative condition, but this difference was only significant for the non-critical conditions (see Figure 6A). These results did not replicate Kuschert's results. A second experiment was designed to find out whether the differences reflect differences in methodology (segment vs. sentence reading times). In this experiment, instead of presenting the stories sentence-by-sentence, the stories were presented segment-by-segment, self-paced by the participants, with the segment borders being assigned to the materials according to Kuschert's criteria. We analyzed the reading times for the final segment of the anaphoric sentences. The results replicated those of the first experiment: Reading times were significantly longer after negative than after affirmative sentences, but this difference was only

significant in the non-critical conditions (see Figure 6B). Thus, the fact that the results did not replicate the results by Kuschert cannot be due to differences in the experimental procedure.

Table 1. Sample text for the study in Kaup, Dijkstra and Lüdtkke 2005

Setting	We were awaiting company for the weekend. Hours before Uncle Sam was supposed to be arriving my whole family was already panicking.
Introducing Sentence [Aff]	My brother Stanley assured everybody that our sister had made a cake.
[Neg]	My brother Stanley objected to the statement that our sister had not made a cake.
Anaphor Sentence [Critical]	He told us that he had seen it in the kitchen just now.
[Non-Critical]	He told us that he had seen her in the kitchen just now.
Final Sentence	We were really glad when Uncle Sam finally arrived and everything went fine.
Question	Did the visitor arrive?

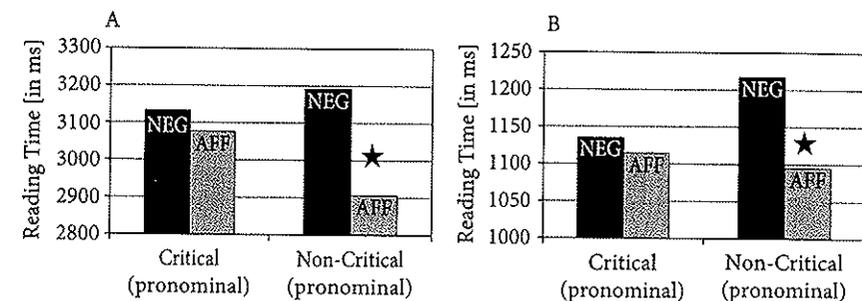


Figure 6. A: Mean reading times for the anaphoric sentences in Experiment 1 of Kaup, Dijkstra and Lüdtkke, 2004. B: Mean reading times in Experiment 2 of this study.

What then are the implications of these results? Contrary to the predictions of the accommodation account, anaphors referring to the *critical entity* were not resolved more slowly after a negative than after an affirmative sentence. Instead the predicted polarity effect was obtained in the *non-critical* conditions. Why should the polarity of the introducing sentence affect the accessibility of the non-critical entity? In the following we will discuss an account of the results (*foregrounding account*) that rests on the assumption that comprehenders spontaneously resolve the double negation when processing the introducing sentence in the negative condition. As a result, the critical entity is represented as if it had been represented in an affirmative phrase. According to the foregrounding account, the results obtained



in Experiments 1 and 2 reflect two (partly counteracting) phenomena: First, the processing of the introducing sentence can be assumed to be more difficult in the negative than in the affirmative condition, because the initial representation is far more complex in the former than in the latter case (see Figure 4 above). These difficulties may “spill over” to the anaphor sentence, in the sense that not in all cases are participants done with their representation for the negative introducing sentence when they begin processing the anaphor sentence. As a result, the processing of the anaphor sentence is slowed down in the negative conditions. Second, in those cases where participants do have completed their representation (and accordingly have resolved the double negation in the negative condition), the critical entity is relatively highly accessible in the negative conditions, because participants take the relatively complex construction that is used to convey the existence of the critical entity in the negative conditions as a signal that this entity is important for what is to come. This foregrounding of the critical entity in the negated conditions facilitates anaphor resolution and neutralizes the spill-over effect from the previous sentence in the critical conditions.

Two further experiments were designed that investigated this *foregrounding account* of the results. If the foregrounding account is correct, and the critical entity is indeed foregrounded in the negated conditions, then this should be reflected in a repeated-name penalty (Gordon, Grosz and Gilliom 1993) when a repeated-name anaphor is being used instead of a pronoun: Entities in the discourse focus are usually referred to by means of a pronoun. If instead of a pronoun a repeated name is being used for referring to an entity in the discourse focus, anaphor resolution is hampered, and resolution times are prolonged. Thus, if using a repeated-name anaphor prolongs the resolution times specifically in the negative-critical condition, then this can be interpreted as indirect support for the assumption that the critical entities were indeed relatively highly accessible in the negated conditions. This prediction was examined in Experiments 3 and 4 of this study.

In Experiment 3, participants were presented with the narrative texts employed in the previous experiments except that only the critical entity was being referred to, in half of the cases by means of a pronoun, and in the other half by means of a repeated-name anaphor (*He told us that he had seen the cake in the kitchen just now*). Narratives were presented sentence-by-sentence, self-paced by the participants. As expected, there was a negation-by-anaphor interaction (see Figure 7A). Reading times were longer in the negative than in the affirmative conditions but only with repeated-name anaphors. This fits well with the predictions: In the negated conditions, the target entity is foregrounded and repeated-name anaphors were therefore inadequate (repeated-name penalty). Accordingly, reading times were significantly prolonged in the negative-repeated-name condition. For the affirmative conditions there was a different pattern; here the target entity is not foregrounded, and accordingly repeated names did not hamper but rather help the resolution process (cf. Almor 1999).

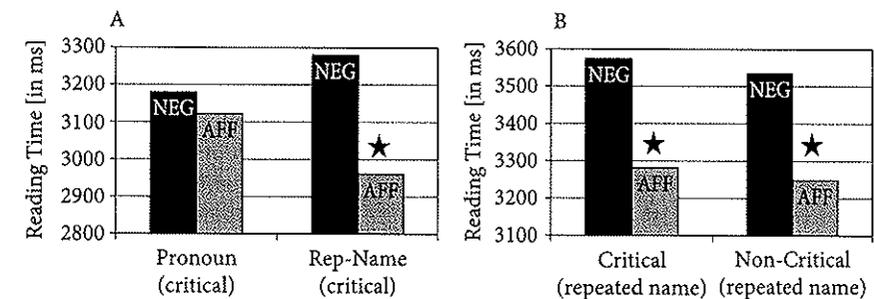


Figure 7. A: Mean reading times for the anaphoric sentences in Experiment 3 of Kaup, Dijkstra and Lüdtkke, 2004. B: Mean reading times in Experiment 4 of this study.

Experiment 4 investigated the prediction that a main effect of negation would occur when repeated names are used for both the critical and the non-critical conditions. Participants were presented with the narrative texts employed in Experiments 1 and 2 except that all anaphors were repeated-name anaphors (*He told us that he had seen the cake / our sister in the kitchen just now*). Narratives were presented sentence-by-sentence, self-paced by the participants. As expected, there was a significant main effect of negation (see Figure 7B). This provides additional evidence for the idea that the critical entity is foregrounded in the negated conditions. A repeated-name penalty reduces the relative advantage of the critical entity in the negated condition. Consequently, the negation effect is now also significant for the critical-antecedent conditions.

Taken together the results of Experiments 3 and 4 supported the foregrounding account. Specifically, the results supported the assumption that the critical entity is foregrounded after processing the introducing sentence in the negative version. This indirectly suggests that comprehenders spontaneously resolved the double negation when processing the introducing sentences. In other words, in contrast to what the accommodation hypothesis assumes, it seems that accommodation is not triggered by an anaphoric element but takes place as soon as its licensing conditions are met— a double negation is resolved independent of whether there is an anaphor referring to an inaccessible discourse referent or not.

Thus, taken together, the results of the four experiments can be explained by two assumptions: First, negative sentences are more difficult to process than affirmative sentences, and this difficulty may spill over to subsequent sentences. Second, when processing double negations as in (5) or (7), participants “calculate” the content of the actual state of affairs. As a consequence, the critical entity becomes foregrounded and relatively highly accessible. With respect to the DRT-based accommodation assumption we can conclude that accommodation is not (only) triggered by an anaphoric element that can otherwise not be resolved. Rather, it seems that accommodation can take place whenever its licensing conditions are met: When the comprehender has created a DRS in which a discourse referent is embedded in an inaccessible sub-DRS,

and this DRS is logically equivalent to a DRS, in which the respective discourse referent is accessible, then the comprehender spontaneously creates this "simpler" DRS, to the effect that the respective discourse referent becomes accessible for subsequent anaphor resolution.

What are the implications of these considerations with respect to the bathroom sentences discussed in the introduction of this chapter? As was briefly reported above, in Kuschart's experiment, bathroom sentences and double-negation sentences produced equivalent results. We were unable to replicate Kuschart's result with double-negation sentences, and as of yet it remains unclear why. The question arises whether we can replicate Kuschart's results with bathroom sentences. If the above considerations are correct, it seems that we might: In bathroom sentences [e.g., (9), here repeated as (13)], the anaphoric element is encountered immediately after the processing of the phrase containing the negation operator, and more important, prior to the sentence boundary. Considering that creating a DRS with an embedded sub-DRS is time-consuming, it seems well possible that accommodation has not yet taken place when the anaphoric element is being encountered. As a consequence, the critical entity may still be encapsulated by the negation operator, and anaphor resolution should be difficult. There is another aspect in which bathroom sentences differ from the double-negation sentences: In double-negation sentences, the discourse referent representing the critical entity is accessible in the main DRS as a result of the accommodation process, or in other words, it stands for an entity that exists in the described world. In contrast, in bathroom sentences the respective discourse referent is embedded even after the accommodation process has taken place. In other words, the sentence does not provide definite information with respect to the existence of the critical entity (it is not definite but only possible that the critical entity exists; see Figure 5B). It seems well possible that accommodation takes place spontaneously only when accessibility in the main DRS is at stake. If so, then comprehenders of bathroom sentences can not be expected to accommodate prior to encountering the anaphoric element in the second clause.

(13) Either Peter did not catch a train, or else it will arrive very late in the evening.

In any case, if either of these assumptions is correct then the critical entity should not be foregrounded when the anaphoric element is encountered in bathroom sentences. Thus, in contrast to what was found with double-negation sentences, we should not find evidence for a relatively high accessibility of the critical entity, nor a repeated-name penalty. These predictions were investigated in two experiments. In the first experiment, pronouns were used for referring to the critical and non-critical entity. Thus, this experiment was equivalent to Kuschart's experiment with bathroom sentences. In the second experiment, we replaced the pronouns by repeated-name anaphors.

### 3 Current Study: Bathroom Sentences

#### 3.1 Experiment 1

##### 3.1.1 Method

*Participants.* Fifty-six students of the Berlin University of Technology participated for course credit or financial reimbursement of EUR 8,-per hour. All participants were native speakers of German.

*Materials.* The materials consisted of 50 short stories, 16 of which were used as experimental items, 32 as filler items, and 2 as practice items.<sup>3</sup> The experimental items were constructed according to the following schema (see Table 2; for a German example see Table 3): The first two sentences specified the setting of the story. The next sentence (target sentence) mentioned two new entities: The non-critical entity was always referred to by a name (e.g., *Peter*) or a definite noun phrase (e.g., *the building*), whereas the critical entity was always introduced via an indefinite noun phrase (e.g., *a train, an elevator*). Both entities were introduced in the first of the two clauses that made up this sentence. In the second clause, the sentence pronominally referred to either the critical entity or the non-critical entity. In the affirmative version, the target sentence was an implication (e.g., *If Peter catches a train, it/he will arrive late*). In the negative version the target sentence was a bathroom sentence (e.g., *Peter either does not catch a train, or it/he will arrive late.*). The next sentence was the final sentence of the story. The filler stories were of comparable lengths and topics as the experimental stories and served to obscure the manipulation. Sixteen of the filler stories contained a negation somewhere in the story, whereas the remaining sixteen did not. For each story, a simple comprehension question was constructed with half of the comprehension questions requiring a 'yes' response and the other half requiring a 'no'-response.

*Design and Procedure.* Each participant read all 16 experimental items intermixed with all 32 filler items. The 16 experimental items were assigned to four sets, the 56 participants to four groups, and the assignment of versions to sets and groups was according to a 4×4 Latin square. Thus we employed a 2(polarity: affirmative vs. negative) × 2(antecedent: critical vs. non-critical) × 4 group/set design with repeated measurement on the first two variables. Text presentation was segment-by-segment, self-paced by the participant pressing the space-bar, according to a moving-windows procedure (Haberlandt 1994). Pressing the space-bar after reading the final segment of the final sentence of the story elicited the presentation of the comprehension question. Participants responded by pressing the appropriate key ('.'- and 'x'-key, marked with 'y' and 'n', respectively). The experimental session lasted approximately 30 minutes.

3. We thank Susanna Kuschart for providing us with her experimental materials. Many of the narratives employed in this study are based on her originals.

Table 2. Sample text

Setting	My roommate Carol and I / decided to remodel / the kitchen of our apartment. / In addition to painting the walls, / we also wanted to get / some new kitchen furniture. / Today, Carol suggested / that we go to John's carpentry shop / to get an impression / of his work. / I am not so sure / whether that's worth it.
Target Sentence	
[Neg/Critical]	Either John will not be willing / to build a dining table at all, / or it will be / extremely expensive.
[Neg/Non-Critical]	Either John will not be willing / to build a dining table at all, / or he will be / extremely expensive.
[Aff/Critical]	If John is willing / to build a dining table at all, / it will be / extremely expensive.
[Aff/Non-Critical]	If John is willing / to build a dining table at all, / he will be / extremely expensive.
Final Sentence	Carol persuaded me / to go there anyway.
Question	Was the kitchen to be remodelled?

Table 3. Sample text

Setting	Zu beneiden ist Doris nicht. / An diesem Wochenende / Bahn zu fahren, / wird die Hölle sein.
Target Sentence	
[Neg/Critical]	Entweder wird Doris / keinen Sitzplatz mehr bekommen, / oder er wird / im Raucherabteil sein.
[Neg/Non-Critical]	Entweder wird Doris / keinen Sitzplatz mehr bekommen, / oder sie wird / im Raucherabteil sein.
[Aff/Critical]	Wenn Doris noch / einen Sitzplatz bekommen wird, / dann wird er / im Raucherabteil sein.
[Aff/Non-Critical]	Wenn Doris noch / einen Sitzplatz bekommen wird, / dann wird sie / im Raucherabteil sein.
Final Sentence	Ich kann mir vorstellen, / dass Doris / nach ihrer Ankunft / gerne einen Spaziergang / an der Elbe / machen würde.
Question	Kommt Doris mit dem Flugzeug nach Hamburg?

### 3.1.2 Results and Discussion

The analyses were performed on the segment reading times in the experimental stories. More specifically, we analyzed the reading times for the final segment of the target sentence, which always was the segment following the one containing the anaphoric expression.

Reading times longer than 8000 ms or shorter than 400 ms were omitted, as well as reading times falling outside 1,458 standard deviations (cf. Selst and Jolicoeur 1994)

from the item's mean in the respective condition (this eliminated less than 5% of the data). We submitted the remaining segment reading times to two analyses of variance, one based on participant variability (F1) and one based on item variability (F2). The mean of the reading times in the four different conditions are displayed in Figure 8: When the sentences referred to the critical entity, reading times were longer in the negative than in the affirmative condition. The same did not hold when the non-critical entity was being referred to. Also, references to the critical entity led to faster reading times than references to the non-critical entity, but only in the affirmative versions of the sentences. These differences were reflected in the statistical analyses. There was a significant main effect of antecedent and a negation-by-antecedent interaction in the analysis by participants, but no main effect of negation (antecedent:  $F(1,52) = 4.4, p < .05; F2(1,12) = 1.5; p = .25$ ; negation-by-antecedent:  $F1(1,52) = 4.4, p < .05; F2(1,12) = 2.1; p = .17$ ; negation: both  $Fs < 1$ ). Planned comparisons revealed a negation effect for the critical but not for the non-critical entity (critical:  $F(1,52) = 4.5, p < .05; F2(1,12) = 4.4; p = .05$ ; non-critical: both  $Fs < 1; F2(1,12) = 1.5; p = .25$ ). An effect of antecedent emerged in the analyses by participants in the affirmative but not in the negative conditions (negative: both  $Fs < 1$ ; affirmative:  $F(1,52) = 8.2, p < .01; F2(1,12) = 3.5; p = .08$ ).

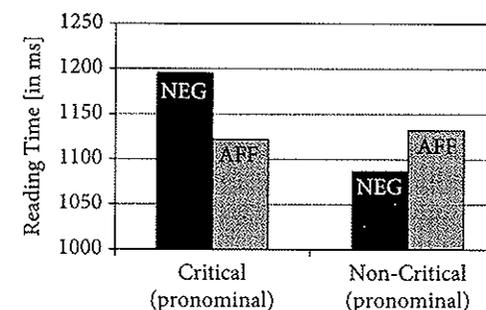


Figure 8. Mean reading times in the four different conditions of Experiment 1.

These results replicate the results that Kuschert obtained with bathroom sentences: Immediately after reading the first clause of a bathroom sentence, the critical entity is relatively low in accessibility. This suggests that at this point in the comprehension process the critical entity was (still) represented in the inaccessible negated sub-DRS in the negative conditions. Thus, in contrast to what was found with the double-negation sentences, the critical entity was apparently not foregrounded when the pronoun was encountered in the bathroom sentence. The fact that in the affirmative conditions, reading times were faster when the anaphor referred to the critical compared to the non-critical entity probably reflects the fact that the critical entity's existence is what the first clause of this sentence is about. That the same advantage for the critical entity was not found in the negative conditions can be counted as further support for the view that the critical entity was relatively low in accessibility in these conditions.

In Experiment 2 we investigated the prediction that we would not find a repeated-name penalty with bathroom sentences. This prediction follows directly from the view the critical entity is not foregrounded in bathroom sentences.

## 4 Experiment 2

### 4.1 Method

**Participants.** Thirty-two students of the Berlin University of Technology participated for course credit or financial reimbursement of EUR 8,-per hour. All participants were native speakers of German.

**Materials.** The materials were the same as those in Experiment 1, except that all antecedents were critical antecedents. Two new conditions were created by replacing the pronoun in the second clause of each experimental sentence by a repeated-name anaphor (e.g., *Peter either did not catch a train or else the train will arrive late*).

**Design and Procedure.** The design was a 2(polarity: affirmative vs. negative)  $\times$  2(anaphor: pronoun vs. repeated name)  $\times$  4 group/set design with repeated measurement on the first two variables. The procedure was the same as in Experiment 1.

### 4.2 Results and Discussion

Outlier elimination was performed as in Experiment 1, which in this experiment reduced the data set by less than 3%. The data of one participant was discarded because he or she had made five mistakes with the comprehension questions in the experiment. The mean of the reading times in the four different conditions are displayed in Figure 9.

When a pronoun was used to refer to the critical entity, negative conditions lead to longer segment reading times than affirmative conditions, which replicates the polarity effect observed in the critical-antecedent conditions of Experiment 1. As expected

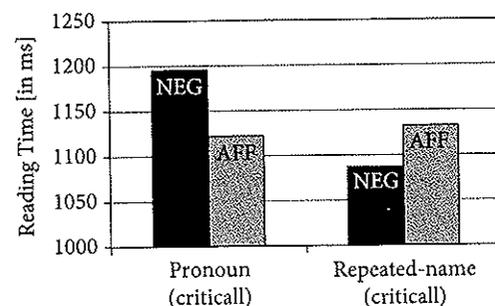


Figure 9. Mean reading times in the four different conditions of Experiment 2.

with respect to a potential repeated-name penalty, we did not find any indication for such a penalty, neither in the affirmative nor in the negative conditions. In the negative conditions, repeated-names even helped the resolution process. Segment reading times were shorter in the negative repeated-name condition than they were in the negative pronoun condition. In affirmative conditions, repeated names and anaphors led to similar segment reading times.

These differences were reflected in the statistical analyses. There was no main effect of polarity (both  $F < 1$ ), and the main effect of anaphor was only significant in the by-participants analysis ( $F(1,27) = 5.2, p < .05; F(1,12) = 2.0; p = .18$ ). However, there was a significant polarity-by-anaphor interaction ( $F(1,27) = 8.0, p < .01; F(1,12) = 5.6; p < .05$ ). Separate analyses for the two anaphor conditions indicated that the polarity effect was significant in the by-participant analysis only when a pronoun was used for reference (pronoun:  $F(1,27) = 4.3, p < .05; F(1,12) = 2.7; p = .12$ ; repeated-name:  $F(1,27) = 3.0, p = .10; F(1,12) = 2.6; p = .13$ ). Separate analyses for the two anaphor conditions indicated that repeated-name anaphors led to shorter segment reading times in the negative conditions ( $F(1,27) = 12.5, p = .01; F(1,12) = 5.2; p < .05$ ) but did not affect reading times in the affirmative conditions (both  $F < 1$ ).

The results nicely match the predictions. Repeated-name anaphors did not lead to prolonged reading times in the negative conditions with critical antecedents. This is in line with the view that the critical entity was not foregrounded in these conditions. Moreover, the fact that repeated-names even helped the resolution process specifically in the negative but not in the affirmative conditions indicates that the critical entity was relatively inaccessible in the negative conditions. This is in line with the view that in the negative conditions, the critical entity was still represented in an inaccessible substructure at the point in time of testing, i.e., at the point in time when the anaphoric element was being encountered.

## 5. General Discussion

In previous studies we investigated the DRT-based accommodation hypothesis with sentences containing a double negation. According to this hypothesis, anaphors referring to entities introduced in a sentence with a double negation should take longer to resolve than anaphors referring to entities introduced in an affirmative sentence, because with the former but not with the latter comprehenders supposedly initiate a time-consuming accommodation process. In contrast to what was found in an earlier study by Kuschert (1999), we did not find positive evidence for this hypothesis. The results of four experiments consistently showed that entities introduced in a sentence with a double negation are relatively highly available shortly after the processing of these sentences. We interpreted these findings as suggesting that the accommodation process is not (only) triggered by anaphoric elements that can otherwise not be resolved. Rather, it seems that comprehenders spontaneously initiate the accommodation mechanism

when processing a sentence with a double negation. As a consequence entities introduced within the scope of a double negation become foregrounded shortly after the processing of the sentence, and accordingly these entities are relatively highly available at this point in the comprehension process.

The experiment reported in the third section of the present chapter investigated the DRT-based accommodation hypothesis with bathroom sentences. With respect to the accommodation hypothesis, bathroom sentences differ in (at least) two relevant aspects from the materials employed in our previous study with double negation. First, the anaphor referring to the entity introduced within the scope of a negation is encountered prior to a sentence boundary. Second, and probably more important, bathroom sentences do not convey definite information with respect to the existence of the critical entity in the described world. Thus, we hypothesized that comprehenders would either not spontaneously accommodate with these kinds of sentences, or alternatively would not yet have initiated the accommodation process when encountering the anaphor in the second clause. Accordingly, we expected the critical entity to be relatively low in accessibility in the negative conditions of the present experiment. In line with this prediction, reading times for the segment following the anaphor in bathroom sentences were relatively long compared to the reading times in equivalent segments in affirmative control sentences. In two further control conditions, in which not the critical entity but the non-critical entity was being referred to, no reading time difference emerged. This rules out an alternative explanation according to which the relatively long reading times in the negative condition are purely due to spill-over effects from the negation in the first clause of the sentences. The fact that with bathroom sentences no repeated-name penalty was observed when instead of a pronoun a repeated-name anaphor was being used for reference, provides further support for the view that the critical entity is not foregrounded in bathroom sentences. Rather it seems that the critical entity is relatively inaccessible: Repeated-names not only did not hamper the resolution process but even helped it. Taken together the results of the two experiments are in line with the hypothesis that in bathroom sentences, the critical entity is still represented in an inaccessible substructure when the anaphoric element is being encountered. The results thereby replicate the results obtained by Kuschert (1999) and suggest that with bathroom sentences, accommodation has not taken place when the anaphoric element is encountered. In principle there are two different explanations for this finding. The first explanation rests on the assumption that comprehenders always spontaneously accommodate, but simply had not yet initiated this process when the anaphor was being encountered in the second clause of the sentences. Thus, this explanation attributes the differences in results to the fact that the anaphor in bathroom sentences is encountered prior to the sentence boundary. The second explanation rests on the assumption that comprehenders only spontaneously accommodate in case an entity can be made accessible in the main-DRS, or in other words, in case accommodation concerns an entity that exists in the described world. Thus, this explanation attributes the differences in results to the fact that bathroom sentences do not convey

definite information with respect to the existence of the critical entity in the described world. It should be noted that this explanation only implies that comprehenders do not *spontaneously* accommodate with bathroom sentences, i.e., prior to encountering an anaphoric element that requires accommodation in order to be resolved. This explanation does not imply that comprehenders do not accommodate at all. Future studies are necessary to find out which of the two explanations is correct. If the first explanation is correct, and comprehenders simply didn't have enough time to initiate the accommodation process in the bathroom sentences employed in our experiment, we might find foregrounding effects with sentences such as (14), in which additional material is inserted in between the disjunction operator and the anaphoric element. On the other hand, if the second explanation is correct, then inserting additional material should not make a difference because the sentence still does not convey definite information with respect to the existence of the critical entity.

- (14) Either Peter does not have a girl friend, or, and in that case I find him very awkward, he simply never brings her to his house.

What are the implications of the present results with respect to the current debate in Psychology concerning the format of the representations employed in language comprehension? According to situation-model theory (e.g., van Dijk and Kintsch 1983; Zwaan and Radvansky 1998), comprehenders create a referential representation which consists of mental tokens that stand for the referents that the linguistic input introduces and refers to. Usually it is (at least implicitly) assumed that the referential level of representation, which consists of mental tokens representing the relevant referents, is augmented by propositions that assign properties and relations to these tokens. Thus in this respect, situation-model theory resembles DRT. In the present chapter we interpreted our results in terms of DRT. We argued that the results can be accounted for if one assumes that accommodation may take place spontaneously. The same post-hoc assumption could be made in situation-model theory, which implies that the results in principle can be accounted for by this theory.

However, in language comprehension research there is growing evidence that suggests that text comprehension is tantamount to the construction of a mental simulation of the described state of affairs. This simulation has been shown to be grounded in perception and action (Barsalou 1999; Glenberg 1997; Glenberg and Kaschak 2002; Zwaan 2004; Zwaan, Stanfield and Yaxley 2002). In experiential simulations, negation cannot be represented explicitly. Instead, it has been proposed that negation is implicitly represented in the simulation processes that are undertaken when processing a negative sentence. More specifically, when processing a negative sentence, the comprehender is assumed to create a simulation of the negated state of affairs that he or she keeps separate from the simulation of the actual state of affairs. The negation is then implicitly captured in the deviations between the two simulations (cf. Kaup and Zwaan 2003; Kaup, Yaxley, Madden, Zwaan and Lüdtkke 2007; Kaup, Lüdtkke, and Zwaan 2006). For instance, when processing a sentence such as *Carl does not have a*

sister, the comprehender is assumed to simulate Carl with a sister (negated state of affairs) as well as Carl without a sister (actual state of affairs). The simulation of the actual state of affairs captures the information that Carl does not have a sister by deviating in this respect from the simulation of the negated state of affairs. The case of double negation (as in *Its not true that Carl does not have a sister*) is more complex: The information from the subordinate clause in the first sentence (i.e., Carl does not have a sister) will lead to representations of Carl with a sister and Carl without a sister (as explained). For the negation in the main clause this two-simulation representation corresponds to the negated state of affairs. The actual state of affairs then again contains Carl with a sister (see Figure 10B). If we compare this representation with the simulation created for the corresponding affirmative sentence (i.e., *It is true that Carl has a sister*; see Figure 10A) it becomes evident that the resulting simulations of the actual states of affairs do not differ. What differs is the simulation history. Thus, to summarize, according to the experiential-simulations view of language comprehension, comprehenders spontaneously resolve the double negation to the effect that embedded discourse entities that exist in the described world become available in the simulation of the actual state of affairs. Thus, overall the experiential-simulations

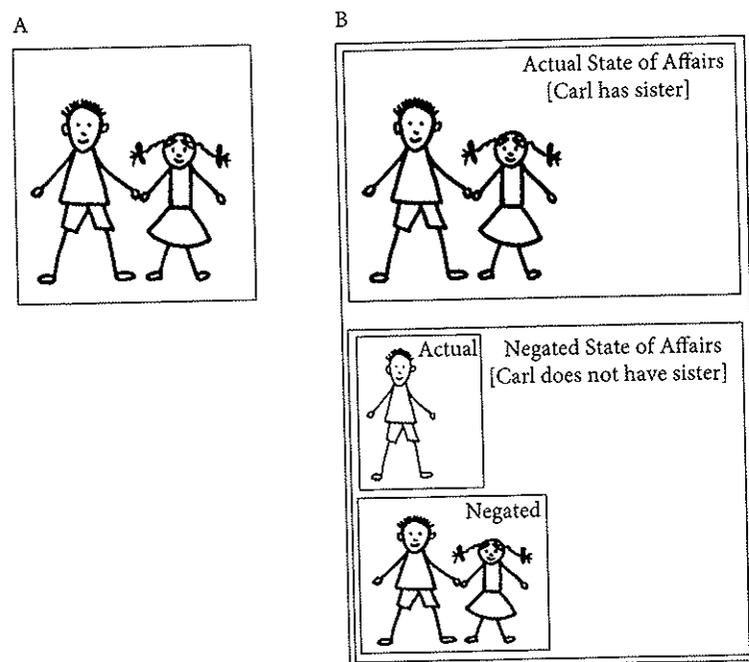


Figure 10. A: Mental simulation for *It is true that Carl has a sister*. B: Mental simulation for *It is not true that Carl does not have a sister*.

account seems to fit nicely with the results of the double negation experiments. In fact, the account has the advantage of predicting that the double negation is being spontaneously resolved when processing the introducing sentence, rather than having to assume this in a post-hoc manner.

How about the results obtained with respect to the bathroom sentences [e.g., (15)]? According to the experiential-simulations account, the first clause leads to a representation of Peter with a girl friend (negated state of affairs) as well as to a simulation of Peter without a girl friend (actual state of affairs). When the disjunction operator is encountered, the comprehender supposedly sets up an alternative simulation of Peter with a girl friend. The immediately following pronoun referring to the critical entity (girl friend) can only be resolved upon completion of this "alternative" simulation. Obviously, the chances that this alternative simulation is already available when the pronoun is being encountered increases with the time that the comprehender has prior to encountering the anaphoric element. In our experiment, the pronoun immediately followed the disjunction operator. Thus, the comprehender had nearly no time to create the "alternative" simulation before encountering the pronoun. From the perspective of the experiential-simulations account, it is therefore not surprising that in the present experiment, the critical entity was relatively inaccessible when the pronoun was encountered. If it turned out that inserting additional material in between the disjunction operator and the pronoun [see (14)] enhances accessibility of the critical entity in the negative condition, then this would further support the experiential-simulations interpretation of the results.

- (15) Either Peter does not have a girl friend, or he never brings her to his house.

## 6 Conclusions

In this chapter we were concerned with the question of whether accessing discourse referents introduced in negated phrases is more time consuming than accessing discourse referents introduced in affirmative phrases. In contrast to what was predicted on the basis of a DRT-based accommodation hypothesis, we did not find evidence for a reduced accessibility in the case of negation in general. Rather, the results suggest that in the case of double negation comprehenders spontaneously resolve the double negation to the effect that embedded discourse referents become accessible in the available discourse representation. The same does not hold in the case of bathroom sentences. Future studies are needed to clarify whether comprehenders generally do not spontaneously accommodate with bathroom sentences, or alternatively whether they simply need more time before encountering the anaphor in these types of sentences. Overall the results can be accounted for by DRT and situation-model theory, in case one adds a post-hoc assumption concerning the accommodation process. The results can also be accounted for by the experiential-simulations account of language comprehension,

with the slight advantage of not requiring post-hoc assumptions. According to this view, negation is not explicitly encoded in language comprehension but implicitly captured in the deviations between two simulations, namely a simulation of the negated state of affairs and a simulation of the actual state of affairs.

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## PART IV

# Language Specific Phenomena