

Title: Content and epistemic relations: a developmental study of recall

Authors: Sara Verbrugge and Aline Sevenants

Affiliation: Laboratory of Experimental Psychology, University of Leuven, Belgium

Address for Correspondence:

Laboratory of Experimental Psychology, KU Leuven, Tiensestraat 102 - bus 3711, 3000

Leuven, België

Tel: +32 16 326132

Fax: +32 16 326099

e-mail: Sara.Verbrugge@ppw.kuleuven.be

Abstract:

The study investigates the types of coherence relations adults and children can recall after having read a text. We discerned content and epistemic relations (Dancygier, 1998; Sweetser, 1990). Content relations express relations between events in reality. Epistemic relations typically express relations between states of thinking (premise-conclusion relations). The relations between the two parts of a content or epistemic relation is often made explicit by means of connectives. The differences between these types of sentences have been shown in different areas (e.g., reasoning, clause integration, acquisition). However, no clear results could be reached as for recall of these relations and the interaction with connectives. We aim to clarify this debate by means of an experiment involving 539 participants. The experiment revealed that the difficulty associated with epistemic relations decreases as participants get older. Interestingly, connectives play a larger role in participants' ability to recall epistemic compared to content relations.

INTRODUCTION

Sentences that have the same outward appearance can be surprisingly differently understood, reasoned with and recalled. This has been shown in the literature time and again. Content effects (such as temporal order, negation, strength of the association between the parts of an utterance, availability of alternatives and disablers) and biases can have a pervasive influence on how people understand sentences that seem to have exactly the same surface structure (Dieussaert, Schaeken, & d'Ydewalle, 2002; Schaeken, De Vooght, Vandierendonck, & d'Ydewalle, 2000; Schaeken, & d'Ydewalle, 1998; Schroyens, Verschueren, Schaeken, & d'Ydewalle, 2000; Verschueren, Schaeken, De Neys, & d'Ydewalle, 2004; Verschueren, Schaeken, & d'Ydewalle, 2005). Also, causal coherence between parts of sentences has been shown to play a major role for a proper understanding of texts (Noordman & Vonk, 1998; Van den Broek, Tzeng, Risdén, Trabasso, & Bashe, 2001).

Consider sentences (1) and (2).

(1) *I dropped a vase. So it broke*

(2) *The lights are out. So the neighbours are not home.*

These sentences have the same outward appearance: two sentences between which a relation is expressed by means of the connective *so*. However, research in both linguistics and psychology has shown that these relations carry different characteristics. They are called **content** (or semantic) and **epistemic** (or pragmatic) **coherence relations**. Roughly speaking, sentences with a content relation express relations between events in reality, whereas epistemic causal sentences express relations between states of thinking (Dancygier, 1998; Dancygier & Sweetser, 2005; Sanders, 1997; Sweetser, 1990). Sentences with a content relation, such as (1), express relations between events in reality: real-world causality connects

the two events described in the two clauses. The first part is often a cause or condition for the second part. Coherence exists because the world that is described is perceived as coherent (Sanders, Spooren, & Noordman, 1992). Content relations hold between the propositional content of the sentences of a text.

(3) *He had been working late yesterday. So he was tired.*

(4) *He was yawning. So he was tired.*

In (3) a relation is expressed between events in the outside world: *being tired* is a result in the real world of *working late*. In epistemic sentences, such as (4), relations between states of thinking are expressed: the speaker arrives at a particular conclusion and gives evidence how he arrived at that conclusion (premise-conclusion relation). Coherence exists because of the writer's goal-oriented communicative acts (Sanders, Spooren, & Noordman, 1992). Epistemic relations hold between the utterances of the text or the beliefs the text is based on (Knott, 2001), e.g., (4). A relation is expressed between beliefs: the speaker infers on the basis of seeing someone *yawning* that that person must also *be tired*. The relation comes into being solely by means of the speaker's inferential system. That is why epistemic relations are also often called inferential relations.

Content and epistemic relations are often used to venture hypotheticalities about possible outcomes of events and thus occupy a very valuable position in everyday thinking and reasoning about both the future and the past. Overall, epistemic relations are said to be more complex as regards reasoning and epistemic relations are later acquired.

The relations between the two parts of a coherence relation can, but need not be made explicit by means of **connectives** (e.g. *so, therefore, because*). Connectives give instructions how to integrate the second segment with the first one.

Below we will go deeper into the difference between content and epistemic relations and the importance of connectives for these relations.

Content and epistemic relations

Differences between content and epistemic relations have been shown both in the purely linguistic and the psycholinguistic literature: they were shown to differ with respect to reasoning, clause integration, and acquisition.

As for adult participants, it has been shown that they react differently to content and epistemic relations in a reasoning task. Verbrugge, Dieussaert, Schaeken, Smessaert, and Van Belle (2007) have shown that participants reason differently with content and epistemic conditionals. It appears that reasoning is easiest with conditionals that most closely reflect the order of events of the real world.

It has also been shown that content and epistemic conditionals differ on the level of clause integration (Verbrugge & Smessaert, 2011). The difference between antecedent subclauses of content conditionals and those of epistemic conditionals is standardly associated with a high degree versus a lower degree of clause integration with their respective consequent main clauses. Clause integration was measured in terms of the semantic and grammatical compatibility between conditional sentences and alternative formulations by inserting an evidential adverb into the consequent main clause, replacing the subordinating conjunction or clefting the conditional subclause. Clear differences came to the surface between content and epistemic conditionals on these tests. Consider the examples (5-6). Clefting the content conditional (5b) yields a grammatical result with the same basic meaning as the original sentence, whereas this does not hold for the epistemic conditional in (6b).

(5a) If you press the button, the bell rings.

(5b) It is (only) if you press the button that the bell rings.

(6a) If the curtains are closed, the neighbours are on holiday.

(6b) * It is (only) if the curtains are closed, that the neighbours are on holiday.

Acquisition studies have shown that epistemic relations are usually acquired later than content relations (see also Givón, 2009). Kyratzis, Guo, and Ervin-Tripp (1990) and Evers-Vermeul (2005) show via different studies that the epistemic domain seems to be acquired last. Spooren and Sanders (2008) present evidence for the fact that epistemic relations are more cognitively complex.

Kyratzis et al. (1990) make a distinction between three types of causal expressions: Speech Act-Level Causals, Content-Level Causals and Epistemic Causals. In Speech Act-Level Causals (e.g., *Is everything all right? Because you look really sad today.*), “the clause with ‘because’ or ‘so’ justifies why something is said, and why the hearer should comply with what is said, rather than explaining the event that is referred to in the matrix clause” (Kyratzis et al., 1990, p. 205). The Content-Level Causals and Epistemic Causals comply with our definitions given above. The purpose of the study of Kyratzis et al. (1990) was to examine the relative frequency of these three types of causals in child discourse. For the data-analysis, children were divided in three age groups. The first group included children aged 2;4 until 3;6. The second group included children aged 3;7 until 6;6. The third group included children aged 6;7 until 12;0. Kyratzis et al. (1990) observed that epistemic causals were very infrequent for all age groups, contrary to content and speech act causals. They relate this to the fact that “epistemic meanings are more cognitively complex for young children” (1990, p. 209-210).

Evers-Vermeul (2005; see also Evers-Vermeul & Sanders, 2011) conducted an experiment among Dutch children of four and five years old. One of the goals was to investigate whether young children can already produce epistemic relations. Therefore,

particular contexts were manipulated to favour epistemic utterances. She shows that “children as young as four are capable of producing epistemic relations when they have the communicative goal of persuading someone, which is the case in an argumentative context” (2005, p. 235). Moreover, the five year old children produced more epistemic relations than the four year old children. This shows that the ability to produce epistemic relations increases with age. In another, longitudinal study, investigating the acquisition order of the domains by observing emergence and use of connectives such as ‘because’ (*omdat*), ‘because/for’ (*want*), ‘that’s why’ (*daarom*), ‘so’ (*dus*) in the different domains, Evers-Vermeul shows that “the epistemic domain seems to be acquired last” (2005, p. 243). However, she also claims that the different contexts in which the sentences are uttered plays a crucial role.

Spooren, Tates, and Sanders (1996) conducted an experiment with six-seven year olds and eleven-twelve year olds. Overall, children produced more semantic than pragmatic relations. Young children produced proportionally fewer pragmatic relations than older children. Spooren et al. (1996) explain this by referring to the fact that semantic relations are cognitively less complicated than pragmatic relations. They claim that, in general, less complex relations are acquired before more complex situations.

Connectives and epistemic modal markers

As we have briefly indicated above, the two parts of a coherence relation can be integrated by means of a connective. Connectives (and often also modal markers) can influence the ease of understanding of these types of relations. Evidence has been adduced that particular contexts and settings can enhance the use and understanding of epistemic relations, which are by default the more complex and more difficult type of relation for children. Here we explore the contribution of epistemic modal elements and connectives to the straightforwardness with which epistemic relations are understood.

Traxler, Sanford, Aked, and Moxey (1997) showed that the use of modal constructions can help the reader in the direction of a particular interpretation. They conducted a reading time experiment with causal (i.e., content) and diagnostic (i.e., epistemic) sentences involving *because* (e.g., causal sentence: *Tina had to walk five miles because her engine stalled on the motorway*; diagnostic sentence: *Tina ran out of gas because her engine stalled on the motorway*). Overall, the processing of the second clauses of diagnostic sentences took longer than the processing of the second clauses of causal sentences. Yet, in their second experiment they report that when a particular modal construction (e.g. *perhaps, maybe, might*) was added, reading times decreased considerably for the second clauses of the diagnostic sentences. They were then as easily processed as causal sentences. Diagnostic interpretations become more readily available and are consequently more easily processed.

In Verbrugge (2007) two elicitation tasks with children and adults showed that adults produce more epistemic conditionals spontaneously than children. Moreover, the use of epistemic markers (i.e., markers indicating the speaker's stance towards the truth or falsehood of an utterance; e.g., 'may well' (*zal wel*), 'probably' (*waarschijnlijk*), 'then it means that' (*dan betekent dat*)) helps to boost the production of epistemic relations, both for children and adults. It has been stated in the literature (Bloom, Lahey, Hood, Lifter, & Fiess, 1980; Evers-Vermeul, 2005; Kyratzis et al., 1990) that content relations are acquired before epistemic relations. Verbrugge (2007) has added that even in the later phases of language acquisition (9 until 12 years old) children still have a clear preference for content conditionals. They spontaneously use fewer epistemic conditionals than adults. The two experiments also revealed that, when participants are asked to insert particular epistemic markers into the consequent of their conditionals, the number of epistemic conditionals increases both for adults and children. The fact that the insertion of epistemic markers can speed up the processing of epistemic sentences has been repeatedly shown in reception studies involving

adult participants (Sanders & Noordman, 2000; Traxler et al., 1997). However, Verbrugge (2007) has contributed that the effect of epistemic markers is also prominent in production studies and extends to children.

Recall of coherence relations with(out) connectives

Although the differences between content and epistemic coherence relations have been shown on different levels (as we outlined above), no clear results could be reached as regards recall of these relations and the interaction with the presence of connectives (e.g. Cain & Nash, 2011; Degand & Sanders, 2002; Kamalski, Sanders & Lentz 2008; Millis & Just, 1994; Sanders, Land & Mulder, 2007). Some papers have studied the influence of coherence in a text on comprehension and recall of fragments of the text. However, a conclusive picture could not be reached. Martins, Kigiel, and Jhean-Larose (2006), Millis, Graesser, and Haberlandt (1993) and Sanders and Noordman (2000) have shown that adding connectives did not improve performance in tasks participants had to perform after reading.

Martins et al. (2006) conducted a study involving the connective ‘that’s why’. They showed that adding this connective did not improve recall of the relations (i.e., the recall of textbase-related information). The connective did not improve performance in the after-reading task (2006, p. 8). Neither did Millis et al. (1993) find a positive effect of adding this connective to the recall of encyclopaedic texts, in their study on the causal connective ‘because’.

Similarly, Sanders and Noordman (2000) did not find a lasting effect of signalling coherence relations by means of causal connectives. While the effect is often present during reading, it disappears afterwards. They claim that relational markers have an effect during online processing, but that the influence of connectives decreases afterwards (2000, p. 37). Martins et al. (2006, p. 9) provide the following rationale for this effect: “One possible reason for this is that connective processing is made too quickly and so does not permit a positive

effect on long term memory. It is perhaps possible to enhance this type of processing by inviting readers to consider more deeply the semantic causal meaning of the causal connectives”.

All these studies seem to suggest that the effect of adding connectives to make a text more coherent is transient. It may help in order to better understand texts during reading, but the effect disappears quickly once the texts are not present anymore. Positive effects of connectives on long term memory could not be shown. With our study below, we take the edge of this finding and demonstrate that there is more to it than meets the eye: age, type of coherence relation and connective all play a role for the recall of fragments of texts. Because effects of connectives for the online reading process have been shown over and over again, we focus only on the recall of coherence relations with and without connectives in order to reach more transparency concerning this topic. We aim to show that there is an important developmental perspective involved in the contribution of connectives to the comprehension of content and epistemic relations. Moreover, the manipulation of the type of recall task should not be underestimated.

Hypotheses

In the experiment we investigate the comprehension of content and epistemic relations in relation to the use of connectives by means of recall questions. We test whether content relations stick better in memory than epistemic relations. Are participants clearly better at answering recall questions about content relations than about epistemic relations? Do children and adults read these relations in a similar way, or do children encounter more difficulties with epistemic relations than adults? Is there a beneficial effect of connectives and does it interact with the other variables? We will discuss our findings in the light of the linguistic skills required to understand and produce relations in the content and the epistemic domain.

Several authors have addressed the issue that free recall might not be sensitive enough to find effects of marking local coherence relations (Kamalski, 2007; Sanders, 2001). In order to overcome this obstacle, we asked the participants specific questions about text fragments after they had read texts (see appendix).

On the basis of the relevant literature we reach the following hypotheses:

- 1) Content relations will be easier to recall than epistemic relations. Precisely because epistemic relations are more complex, we think people will encounter more difficulties when they have to recall epistemic relations than the straightforward content relations.
- 2) Relations with a connector will be easier to recall than relations without a connector.
- 3) We hypothesize an age effect: adult participants will recall more relations than younger participants simply because they have better working memory capacities. Moreover, we think that the variable age will interact with the presence of connectives and the type of relation.
- 4) We hypothesize there will be an interaction between presence/absence of connective and type of relation. Because epistemic relations are more complex, we think participants reading epistemic relations will benefit more in recall questions when a connective was present in the text that explicated the relation.

EXPERIMENT

METHOD

Participants

In total 539 children and adults participated in the experiment: 169 9-10 year olds; 192 11-12 year olds; and 178 17-18 year olds. These children and students read a text comprising content and epistemic relations, either with or without connectors. Participants were asked to read texts comprising content and epistemic relations and answer comprehension questions about these relations after having read the texts.

Materials, Procedure and Design

The participants read the texts in Dutch, their mother tongue. All the relations studied involved the connective 'so' (*dus*). Every participant was given four short stories to read. These stories were based on existing children's stories (see appendix for an example), but were adapted in order to fit the standards of the experiment. Participants were instructed to read the text and explained that they would receive comprehension question afterwards. Before starting with the actual experiment, the participants were given a story and questions in order to get used to the procedure. Participants read the text. After that, the text was taken away and they had to fill in four questions per story on a piece of paper.

The same stories were given to all four groups, however two groups were given the stories with connectives (group 1 and 2), while the two other groups were given the stories without connectives (group 3 and 4). Recall questions were manipulated between subjects. The first and third group were asked recall questions about the content relations, the second and fourth group about the epistemic relations. Both content and epistemic relations were present in all texts.

Four recall questions were asked per story, so participants had to answer 16 questions in total. The analysis was run on the number of correct answers participants gave out of the possible 16.

RESULTS

An analysis of variance was conducted with age, type of relation and presence of connective as between subjects variables. There was a main effect of connective; relations with connective (mean=12.93) were easier to recall than relations without connective (mean=11.57) ($F(1,527)=62.6; p<.0001$).

There was a main effect of type of coherence relation, with content relations (mean= 12.89) being easier to recall than epistemic relations (mean= 11.61) ($F(1,527)=56.3$; $p<.0001$).

As expected, there was a main effect of age with the youngest children (mean= 10.20) doing worse than the older children (mean= 12.34), who did in turn worse than the adults (mean= 14.21) ($F(2,527)=176.17$; $p<.0001$).

There was an interaction effect between age and coherence relation ($F(2,527)=10.98$; $p<.0001$), with the interesting finding that the difficulty associated with epistemic relations (compared to content relations) decreases as participants get older (see Figure 1).

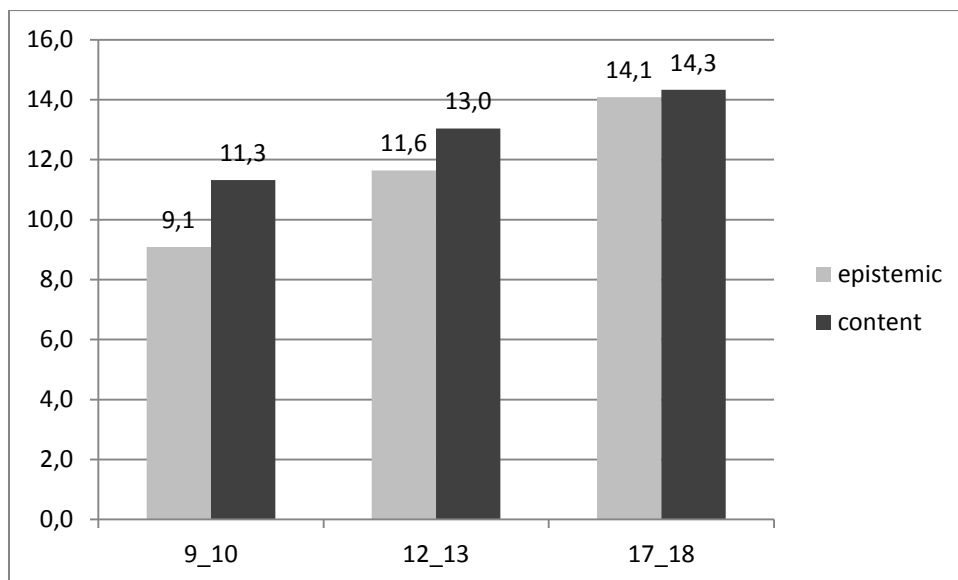


Figure 1. Interaction between type of coherence relation and age.

Finally, there was an interaction effect between connective and coherence relation ($F(1,527)=7.35$; $p<.01$) to the extent that connectives play a larger role in epistemic relations compared to content relations (see Figure 2).

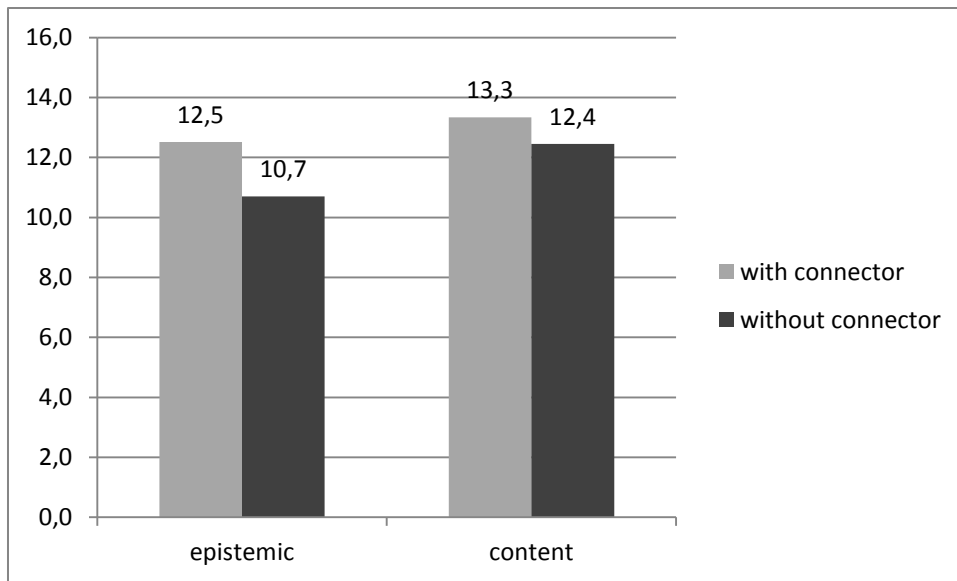


Figure 2. Interaction between type of coherence relation and presence/absence of a connector.

DISCUSSION

Type of coherence relation

The experiment revealed that content relations are better recalled than epistemic relations for the younger age groups. Content relations are easier to recall because there is a one-to-one correspondence with reality. Epistemic relations are harder because they require extra steps. They are no description of reality but present a form of thinking about reality. The experiment has shown that content relations are easier to recall than epistemic relations for children. It is the first time that this has been unequivocally shown. Sanders and Noordman (2000) found a difference between the recall of problem-solution coherence relations and list coherence relations. They found this effect in a free recall task. It seems not so surprising that relations that are joined by a causal relation are better recalled than simply lists of things. However, our study has for the first time shown that two groups of coherence relations can be successfully distinguished as regards recall. Moreover, this had been done by a task consisting of precise questions concerning the coherence relations. This means that the possible interfering factor

of participants only recalling what they thought relevant (which is often the case in a free recall task) was ruled out in our task.

Age effect

Children encounter more difficulties with epistemic relations than adults. Interestingly, the difficulty associated with epistemic relations (compared to content relations) decreases as participants get older. This can be interpreted as in line with the study of Martins et al. (2006) who showed that experts performed better than novices because they possess more general knowledge about events etc. Needless to say, the older children become, the more they are aware of the general workings of the world and the more they are used to inferring information from texts (see also: Denhière & Baudet, 1992).

On the basis of this recall study we have been able to show that content relations appear to be easier to understand and recall for younger children. As children grow older, there is a gradual increase in the recall of epistemic relations. Apparently, it takes some time before children have fully acquired the epistemic relations. These data from language acquisition converge with data from language processing and diachronic linguistic research. The fact that the content meaning seems to be the one that is acquired first, is in line with results from other sources: content readings are more syntactically entrenched (Dancygier, 1998; Haegeman, 1991, 2003; Verbrugge & Smessaert, 2011), more easily processed (Noordman & de Blijzer, 2000) and also diachronically the central meaning from which the other classes are metaphorical extensions (cf. evidence such as Hopper & Traugott, 1993, 2003; Traugott, 1989).

Presence or absence of connective: implicit versus explicit

Relations with connective were easier to recall than relations without connective. The results obtained in the recall task run counter to the existing (cf. Martins et al., 2006; Millis et al., 1993; Sanders & Noordman, 2000) literature that states that connectives only influence the

reading process itself, but not the recall of the relations afterwards. Interestingly, connectives were shown to play a larger role for participants to be able to recall epistemic compared to content relations. Precisely because these epistemic relations are more complex, connectives carry a greater beneficial effect in the recall of these relations. While literature was in doubt about recall, we have been able to show that connectives play a vital role for better remembering coherence relations.

The claim that the positive effects of connectives are only transient, only playing a role during the reading of the texts, does not hold.

GENERAL DISCUSSION

In this study, we have focused on content and epistemic coherence relations involving the connective ‘so’ (*dus*) and on the developmental aspect of the acquisition of content and epistemic relations. We have studied the interaction with connectives, something which has not been done in the past. This led to surprising results. While coherence of a text is a crucial factor for a proper understanding, previous studies were not able to draw a conclusive picture of the (un)beneficial aspect of connectives for the recall of information in texts.

By means of the recall task we have been able to show that connectors play a larger role for the recall of epistemic relations compared to content relations and that younger participants encounter more difficulties with epistemic relations than adults. We did not make use of free recall, because in that case there is no control whether the participant could not recall a particular part of a sentence or simply did not think it relevant. By asking specific questions we were able to compare all conditions.

The results of the recall study are in line with previous research involving reading times (Traxler, Bybee, & Pickering, 1997; Noordman & De Blijzer, 2000). Epistemic relations require longer reading times than content relations, showing that they need more time in order to be properly processed. This complexity of epistemic relations was found in

the recall study in that they linger worse in memory than content relations do. A novel finding was that connectives play a more important role for the recall of epistemic than content relations. Apparently, adding connectives to epistemic relations makes them easier to understand and recall. There was also an effect for content relations, but smaller, showing that content relations are often understandable enough without further explicitation or elucidation.

In conclusion, we can say that this study has shown that the precise type of relation that is expressed is an important factor for its ease of recall. Moreover, this variable was shown to interact with the age of the participants and the presence or absence of a connective. Specific small additions in language can have a huge effect for memory. This way, this study fits into the tradition in reasoning that has developed over the last thirty years showing that content and coherence effects play a huge role in reasoning with and understanding of sentences and texts.

ACKNOWLEDGEMENTS

We want to thank the anonymous referee for his or her helpful comments on an earlier version of this paper. The remarks have significantly improved both the argumentation and the readability of the text. Needless to say, all remaining errors are our own responsibility.

REFERENCES

- Bloom, L., Lahey, M., Hood, L., Lifter, K., & Fiess, K. (1980). Complex sentences: Acquisition of syntactic connectives and the semantic relations they encode. *Journal of Child Language*, 7, 235-261.
- Cain, K., Nash, H. (2011). The influence of connectives on young readers' processing and comprehension of text. *Journal of Educational Psychology*, 103(2), 429-441.
- Dancygier, B. (1998). *Conditionals and prediction. Time, knowledge and causation in conditional constructions*. Cambridge: Cambridge University Press.
- Dancygier, B., & Sweetser, E. (2005). *Mental spaces in grammar: Conditional constructions*. Cambridge: Cambridge University Press.
- Degand, L. & Sanders, T.J.M. (2002). The impact of relational markers on expository text comprehension in L1 and L2. *Reading and Writing*, 15(7-8), 739-757.
- Denhière, G., & Baudet, S. (1992). *Lecture, compréhension de texte et science cognitive*. Paris: Presses Universitaires de France.
- Dieussaert, K., Schaeken, W., & d'Ydewalle, G. (2002). The relative contribution of content and context factors on the interpretation of conditionals. *Experimental Psychology*, 49 (3), 181-195.
- Evers-Vermeul, J. (2005). *The development of Dutch connectives. Change and acquisition as windows on form-function relations*. Doctoral Dissertation, Utrecht Institute of Linguistics, The Netherlands.
- Evers-Vermeul, J. & Sanders, T.J.M. (2011). Discovering domains - On the acquisition of causal connectives. *Journal of Pragmatics*, 43(6), 1645-166.
- Givón, T. (2009). *The genesis of syntactic complexity. Diachrony, ontogeny, neuro-cognition, evolution*. Amsterdam: John Benjamins.

- Haegeman, L. (1991). Parenthetical adverbials: the radical orphanage approach. In S. Chiba, A. Shuki, A. Ogawa, Y. Fuiwara, N. Yamada, O. Koma, & T. Yagi (Eds.), *Aspects of modern English linguistics: Papers presented to Masatomo Ukaji on his 60th birthday* (pp. 232–254). Tokyo: Kaitakushi.
- Haegeman, L. (2003). Conditional clauses: external and internal syntax. *Mind & Language*, 18, 317-339.
- Hopper, P., & Traugott, E.C. (1993/2003). *Grammaticalization*. Cambridge: Cambridge University Press.
- Kamalski, J. (2007). *Coherence marking, comprehension and persuasion. On the processing and representation of discourse*. Dissertatie. Universiteit Utrecht, Utrecht.
- Kamalski, J, Sanders, T., & Lentz, L.R. (2008). Coherence marking, prior knowledge and comprehension of informative and persuasive texts: Sorting things out. *Discourse Processes*, 45, 323-345.
- Knott, A. (2001). Semantic and pragmatic relations and their intended effects. In T. Sanders, J. Schilperoord, & W. Spooren (Eds.), *Text representation: Linguistic and psycholinguistic aspects* (pp. 127-151). Amsterdam: Benjamins.
- Kyrtziz, A., Guo, J., & Ervin-Tripp, S. (1990). Pragmatic conventions influencing children's use of causal constructions in natural discourse. In *Proceedings of the Sixteenth Annual Meeting of the Berkeley Linguistics Society* (pp. 205-214). Berkeley: Berkeley Linguistics Society.
- Noordman, L., & De Blijzer, F. (2000). On the processing of causal relations. In E. Couper Kuhlen, & B. Kortmann (Eds.), *Cause-condition-concession-contrast: Cognitive and discourse perspectives* (pp. 35-56). Berlin: Mouton de Gruyter.
- Noordman, L., & Vonk, W. (1998). Memory-based processing in understanding causal information. *Discourse Processes*, 26, 191-212

- Martins, D., Kigiel, D., & Jhean-Larose, S. (2006). Influence of expertise, coherence, and causal connectives on comprehension and recall of an expository text. *Current Psychology Letters*, 20 (3).
- Millis, K., Graesser, A.C., & Haberlandt, K. (1993). The impact of connectives on memory for expository texts. *Applied Cognitive Psychology*, 7, 317-340.
- Millis, K., & Just, M. (1994). The influence of connectives on sentence comprehension. *Journal of Memory and Language*, 33(1), 128-147.
- Sanders, T. (1997). Psycholinguistics and the discourse level: Challenges for cognitive linguistics. *Cognitive Linguistics*, 8(3), 243-265.
- Sanders, T. (2001). From the structure and coherence of informative texts to cognitive criteria for text quality? Two case studies. In L. Degand & et al (Eds.), *Multi-disciplinary approaches to Discourse* (pp. 175-181). Münster: Stichting Neerlandistiek VU / Nodus Publikationen.
- Sanders, T., Land, J. & Mulder, G. (2007). Linguistic markers of coherence improve text comprehension in functional contexts. *Information Design Journal*, 15(3), 219-235.
- Sanders, T., & Noordman, L. (2000). The role of coherence relations and their linguistic markers in text processing. *Discourse Processes*, 29, 37-60.
- Sanders, T., Spooren, W., & Noordman, L. (1992). Towards a taxonomy of coherence relations. *Discourse Processes*, 15, 1-36.
- Schaeken, W., De Vooght, G., Vandierendonck, A., & d'Ydewalle, G. (2000). Strategies and tactics in deductive reasoning. In W., Schaeken, G. De Vooght, A. Vandierendonck, G. d'Ydewalle (Eds.), *Deductive reasoning and strategies* (pp. 301-309). Mahwah, (NJ): Erlbaum.

- Schaeken, W., & d'Ydewalle, G. (1998). Temporal deductive reasoning. In V. De Keyser, G. d'Ydewalle, & A. Vandierendonck (Eds.), *Time and the dynamic control of behavior* (pp. 361-381). Seattle, WA: Hogrefe & Huber.
- Schroyens, W., Verschueren, N., Schaeken, W., d'Ydewalle, G. (2000). Conditional reasoning with negations: Implicit and explicit affirmation or denial and the role of contrast classes. *Thinking and Reasoning*, 6, 221-251.
- Spooren, W., & Sanders, T. (2008). The acquisition of coherence relations: On cognitive complexity in discourse. *Journal of Pragmatics*, 40 (12), 2003-2026.
- Spooren, W., Tate, K., & Sanders, T. (1996). Taalverwerving en de classificatie van coherentierelaties. *Nederlandse Taalkunde*, 1, 26-51.
- Sweetser, E. (1990). *From etymology to pragmatics: metaphorical and cultural aspects of semantic structures*. Cambridge: Cambridge University Press.
- Traugott, E.C. (1989). On the rise of epistemic meanings in English: an example of subjectification in semantic change. *Language*, 65, 31-55.
- Traxler, M., Sanford, A., Aked, J., & Moxey, L. (1997). Processing causal and diagnostic statements in discourse. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 23, 88-101.
- Traxler, M., Bybee, M., & Pickering, M. (1997). Influence of connectives on language comprehension: eye-tracking evidence for incremental interpretation. *The Quarterly Journal of Experimental Psychology*, 50A, 481-497.
- van den Broek, P., Tzeng, Y., Risen, K., Trabasso, T., & Bashe, P. (2001). Inferential questioning: Effects on comprehension of narrative texts as a function of grade and timing. *Journal of Educational Psychology*, 93 (3), 521-529.
- Verbrugge, S. (2007). Frequency and lexical marking of different types of conditionals by children and adults in an elicitation task. In *Proceedings of the 2nd European Cognitive*

- Science Conference* (pp. 179-183). Hove (UK) and New York (USA): Lawrence Erlbaum Associates.
- Verbrugge, S., Dieussaert, K., Schaeken, W., Smessaert, H., Van Belle, W. (2007). Pronounced inferences: A study on inferential conditionals. *Thinking & Reasoning*, 13 (2), 105-133.
- Verbrugge, S., & Smessaert, H. (2011). On the distinction between inferential and meta-inferential conditionals in Dutch. *Journal of Pragmatics*, 43 (14), 3387-3402.
- Verschueren, N., Schaeken, W., De Neys, W., & d'Ydewalle, G. (2004). The difference between generating counterexamples and using them during reasoning. *Quarterly Journal of Experimental Psychology*, 57A, 1285-1308.
- Verschueren, N., Schaeken, W., & d'Ydewalle, G. (2005). Everyday conditional reasoning: a working memory dependent trade-off between counterexample and likelihood use. *Memory and Cognition*, 33, 107-119.

APPENDIX: example of recall task

One Sunday there was a little egg on a small leaf. *It was hot outside. (So) the sun was shining.* All of a sudden the egg opened and a little caterpillar emerged. **The caterpillar was hungry. (So) it went looking for food.** What it liked most of all was fruit. On Monday the caterpillar ate straight through an apple. *Afterwards it went on looking for food. (So) it was still hungry.* On Tuesday it ate straight through two pears. On Wednesday it ate three bananas. On Thursday it ate four oranges. On Friday it ate five strawberries. But it was still hungry. *On Saturday it ate an entire chocolate pie. (So) it had run out of fruit to eat.* **The caterpillar had now eaten too much. (So) its belly hurt. It was no longer hungry. (So) it stopped looking for food.** *Then it was Sunday again. (So) a week had passed.* **It was raining. (So) the caterpillar got wet.** It built itself a house, called a cocoon. It remained in there for a few weeks. Then it made a hole in the cocoon and emerged ... and it had turned into a gorgeous butterfly!

(Based on the story “Rupsje Nooit Genoeg”, original version “The very hungry caterpillar” by Eric Carle)

Content relations are in bold. Epistemic relations are in italics. (Of course this typesetting was not like this in the stories the children and adults read.) Recall questions were asked about the first and the second part of the content and epistemic relations. No differences could be observed between the first and second parts. That’s why that variable was not included in the analysis described in the paper.

Questions concerning first part of content relations:

- Why did the caterpillar go hunting for food?
- Why did its belly ache on Saturday?
- Why did the caterpillar not go on looking for food after Saturday?
- Why did the caterpillar become wet?

Questions concerning second part of content relations:

- What did the caterpillar do when it was hungry?
- What did the caterpillar feel when it had had too much to eat?
- What did the caterpillar quit doing when it was not hungry anymore?
- What happened to the caterpillar when it stopped raining?

Questions concerning first part of epistemic relations:

- How do the children know that the sun shone?
- How do we know that the caterpillar was still hungry after he ate an apple on Monday?
- How do we know that the caterpillar had run out of fruit on Saturday?
- How do we know that a week has passed?

Questions concerning second part of epistemic relations:

- Why was it hot?
- Why did the caterpillar, after having eaten an apple, go hunting for food on Monday?
- Why did the caterpillar eat a chocolate pie on Saturday?
- The story says: and then it was Sunday again. What do we know because of that?